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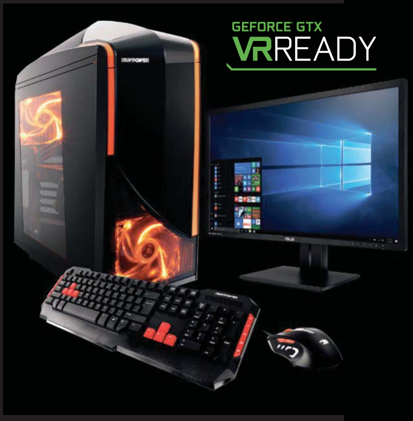

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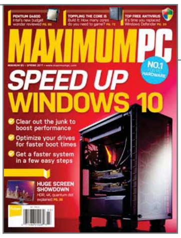

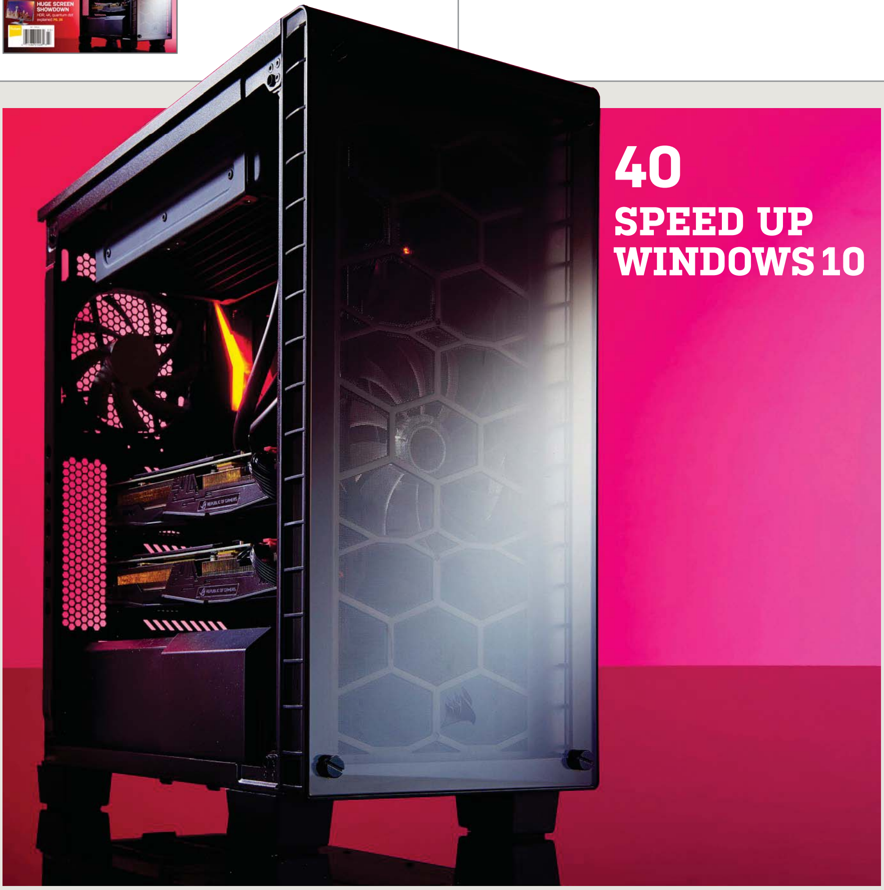

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ART
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BUSINESS
Vice President, Sales: Stacy Gaines, stacy.gaines@futurenet.com
Vice President, Strategic Partnerships: Isaac Ugay, isaac.ugay@futurenet.com
East Coast Account Director: Brandie Rushing, brandie.rushing@futurenet.com
East Coast Account Director: Michael Plump, michael.plump@futurenet.com
West Coast Account Director: Austin Park, austin.park@futurenet.com
West Coast Account Director: Brandon Wong, brandon.wong@futurenet.com
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PRODUCTION
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Tuan
Nguyen

THE NEVER-ENDING PURSUIT OF MORE PERFORMANCE

WE SPEND A LOT OF TIME fussing about with hardware. Tinkering, tweaking, and otherwise trying to squeeze out every last drop of GPU and CPU performance. You can find endless amounts of resources that tell you what you should and shouldn't do with your hardware. But very little attention is given to the operating system side of the computer, which is unfortunate, because that's ultimately where the results matter the most. So we've gone and done just that.

Windows 10 is, without doubt, one of Microsoft's best releases of Windows. It's well made, stable, and chock-full of features—some of which you may not actually want or use. Take, for example, Cortana, the smart assistant not unlike Apple's Siri, Amazon's Echo, or Google Assistant. Sure, it can tell jokes, look up information on Wikipedia, and search your computer, but I personally don't use it. I reckon my keyboard skills can get me what I need much faster. So I disable it, freeing up system resources for other duties.

Things don't end there, though. There are other areas of Windows 10 that you can dive into, and with a little know-how, gain just not increased performance from your PC, but enough performance to witness actual usability improvements. Startup options, system services, clearing out old system update files, and more—our crack team of experts show you a wide range of pro-level tricks to take your rig by the horns.

Some of you might be thinking to yourselves, "Well, I've done all that, but tell me what's going to give me giant leaps in performance on my next upgrade." The answer might surprise you: displays.

Earlier this year, at CES, I witnessed a flurry of display announcements. 8K displays finally debuted, with some companies showing working demos. HDR is on the rise, primarily in HDTVs, but it'll no doubt show up in computer displays this year. Refresh rates are going up, too, and a new HDMI spec was announced, delivering 4K resolution at an astonishing 120Hz. The display industry is moving forward at an ever-increasing rate, and this will also push the PC.

So, we took it upon ourselves to bring all the newest bad-ass displays into the lab, and run them through our tests. Some are better than others, but one result is consistent across the board: Current displays have advanced significantly in just a few years.

Which brings me to my sage advice: Invest in a display. A good display is always the most expensive part of my build, because I spend all my computing time staring at it, and a good display will outlast your PC, for the most part. You might upgrade this and that inside, but the screen will be there for some time.

What do I use? Two 32-inch 4K displays. But with 8K on the way, I'm starting to get an itch.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 20 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Intel's Optane Technology Ships

Commercial 3D memory finally arrives

THE LAUNCH of an M.2 SSD memory module is not normally of much interest, but Intel's new 8000p is based on the company's new Optane technology, which has been several years in the making, and responsible for quite a few promises along the way. The modules come in 16GB and 32GB sizes, and you'll need a specific set of hardware to run them: a Kaby Lake chip, a 200-series chipset, a compatible M.2 slot, and a compatible BIOS. They have been designed to boost Intel's Rapid Cache Technology performance, and a small number of machines have been announced that are Optane-ready, among them Lenovo's ThinkPad T570 and HP's Envy Curved 34.

Optane is Intel's brand name for the 3D XPoint technology, a 3D memory system jointly developed by Intel and Micron. The tech has been in the labs since 2012. Memory cells sit in a three-dimensional mesh, and use the change in resistance of the materials to store data. Importantly, there are no individual transistors. These first modules have two layers of memory cells, but three-layer cells are due later in the year. The exact physics and manufacturing method has yet to be revealed.

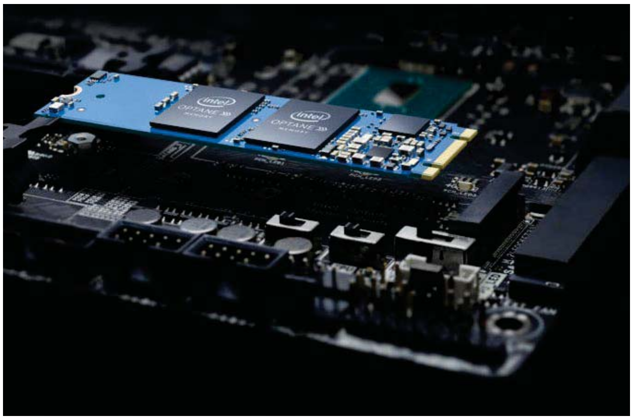
Intel's announcements about Optane veer into hyperbole. It will "change the face of computing with an unparalleled combination of speed, endurance, and density." These first modules are about three times faster than a standard SSD in random and sequential read. Write speeds are less impressive—still capable of beating SSDs, but by much slimmer margins. The 32GB module manages 1,600MB/s on reads and 500MB/s on writes. Latency is between SSD and DRAM. We have nothing on price yet, but they won't be cheap. Expect to pay around five times the price of flash RAM, or twice that of DRAM.

Sure, they are fast, but you are right to feel a little underwhelmed at this point. This doesn't beat emerging NVDIMM or NVMe technology, and isn't what we were promised. Early presentations about 3D XPoint spoke of speed boosts of up to a thousand times SSD, and touched on the long-held dream of unified RAM and storage. Alas, these claims have proved elusive. The tantalizing early proclamations were based on the core performance of the chips at the cell level. Once it goes through all the subsystems of the hardware and software, the speed is degraded considerably. Perhaps it might have been wiser not to publicize such appetizing claims in the first place.

Larger capacity SSD versions are currently being tested in servers by IBM and Facebook. Before the end of the year, we will see more mainstream applications, which currently sport "Beach" codenames—Mansion Beach, Stony Beach, and Carson Beach—each a family of Optane SSDs running on PCIe or SATA. Its future as a DRAM replacement is less obvious. Conventional modules are already cheap and fast, but its use in servers cannot be far away.

Optane is having a slightly difficult birth, and the 8000p is a bit of a dull start. However, a huge research budget and much effort has been poured into its success. This is just a taster. A single unified high-speed memory is still a long way away, but we do have commercial 3D memory that is already faster than NAND, and has an interesting roadmap. You will be hearing a lot more about Optane. **–CL**

> “Memory cells sit in a 3D mesh, and use the change in resistance to store data.



Not quite what we were expecting, but it's a start.

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CHINESE BAN ON VPNs

Free trade for China, but no free Internet

THE CHINESE MINISTRY of Industry and Information has announced the start of a 14-month campaign to target the use of VPNs in China to "clean up" the Internet, and encourage the "healthy" development of the industry. Running a VPN business inside China will now require a state license, and presumably close co-operation with the authorities. President Xi Jinping recently delivered a speech to the World Economic Forum on the benefits of opening up world trade and world borders. The irony is palpable.

Details on the new rules are a little vague, but the clear targets are businesses inside China who provide VPNs for its citizens. The firewall that surrounds China has also started blocking VPN sites. Large corporations are unaffected so far. VPNs are popular in China to access otherwise blocked sites, such as Google and YouTube, and evade censorship on specific subjects, principally anything concerning dissatisfaction with the state.

The Internet arrived in China in 1994, and the state started to attempt to control it in 1998; a firewall for the entire nation followed in 2003. China's efforts to control the Internet were initially greeted with much skepticism in the West. The Internet was seen as too porous and too distributed to be stopped. While it is still difficult to stop a determined individual, the state has proved remarkably effective at suppressing the curious. In China, you expect to be tracked, and self-censorship is natural.

Meanwhile, in the rest of the world, VPNs are free to use and popular, even if the authorities aren't always keen on the uses they are put to. China has shown that it is possible to effectively control what it was once thought almost impossible to police. Let's hope nobody else gets any ideas. **–CL**

3D TV IS DEAD

NO NEW HARDWARE IS BEING BUILT

THE LAST TWO BIG PLAYERS making 3D TVs—LG and Sony—are to drop their support with this year's models. The format is dead, for the mass market at least. Lack of content was obvious; there was very little broadcast 3D, and even that has now stopped. Enthusiasm from consumers dropped off sharply, and the TV people's attention has shifted to HDR and 4K. 3D content will live on, but only through VR.

3D TVs came on the back of 3D movies, which appeared in sporadic waves since the 1950s, each powered by new technology. The first wave lasted just three years, and the revivals fared little better. The current dalliance with 3D movies has at least attracted some big budget titles, but there are signs that this is fading, too. The odds are that 3D will return at some point, probably using yet another technology, but for now you had better start hoarding those 3D Blu-rays if you want any use out of your 3D TV. **–CL**

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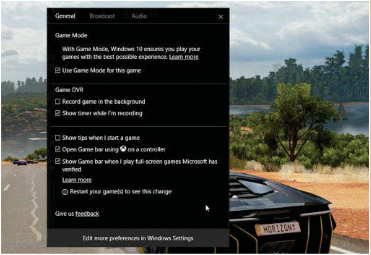

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Give us feedback

Edit more preferences in Windows Settings

PRESS WINDOWS AND G in the latest Windows Creator Update, and you enter the much anticipated Game Mode. As expected, it's mostly about resource allocation, specifically CPU and GPU resources to the game, getting all processor cores running effectively, and keeping the GPU focused on the game graphics. The emphasis is not so much on performance increases—these are marginal, at 2–5 percent—but to get Win 10 rigs, Xbox One, and the forthcoming Scorpio console to offer a consistent experience. The target standard is 900p to 1080p for Xbox One, and 4K at 60fps for Scorpio. The "Games" section in "Settings" sports the Xbox logo, and here you can configure each game. Win32 support has been confirmed, too, which is welcome. You also have game streaming via Beam, and a new Game DVR settings page. It's about blurring the lines between platforms, and focusing on a consistent game experience. **–CL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

DRONEGUN
We now have ray guns that can shoot down drones with concentrated electromagnetic radiation—not available to the public yet, though.

INTEL BACKS 7nm
Intel is building a pilot plant to develop the 7nm process. Moore's Law still has legs.

GOOGLE PARKING
Google Maps will now include a color-coded guide to how difficult it is to park at your destination. Handy.

TRAGEDIES

BURNING LAPTOPS
HP has recalled over 100,000 laptop batteries over issues with overheating and possible fires.

WIN 7 NOT SECURE
It still has three years of official support left, but Microsoft has warned that Windows 7 is now intrinsically insecure.

APPLE SLUMP
Apple's share of the market has dropped to 6.1 percent of PCs online, down from 9.6 percent barely a year ago.

Jarred Walton

TECH TALK

The Current State of Integrated Graphics

THE WORLD OF INTEGRATED GRAPHICS has a long and storied history, most of which can be summed up as: they're too slow and lacking in functionality. For years, the most "popular" graphics chips have been Intel's, not because they were fast but because they were ubiquitous.

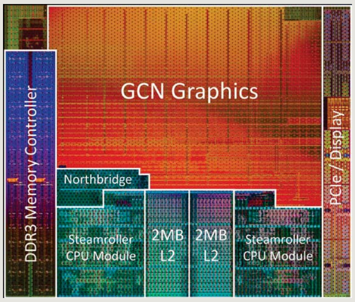
The good news is that Intel started putting more effort into improving graphics when it created HD Graphics, in 2010. The latest iteration is its 600 series, in the new Kaby Lake CPUs, which is largely the same as the 500 series. A huge chunk of the processor is devoted to graphics—roughly one third of the die. But even so, performance isn't stellar.

I ran tests on 15 modern games, and even at low quality settings and 1280x720, less than half were playable. But there is some good news in that all 15 games rendered without any noticeable errors. Less demanding games such as *Overwatch, League of Legends, Counter-Strike: Global Offensive, Dota 2,* and many indie titles are also definitely playable.

Perhaps more interesting is what Intel has been doing over the past seven generations of Core processors. Intel more than quadrupled its mainstream integrated graphics performance going from first-gen to third-gen Core, but since then, most of the desktop parts (Broadwell being the exception) haven't seen much improvement. In raw computational power, the fastest GT2 variants of Intel's HD Graphics have sat in the 400-450Gflops range since Haswell's HD 4600 in late 2012.

AMD is only slightly better, with its top APUs, like the A10-7890K, sitting at 887Gflops, while lower-tier parts like the A8-7670K (581Gflops) and A6-7470K (410Gflops) are well off the pace. More critically, all of these parts, including desktop Skylake and Kaby Lake at 440Gflops, are less than half the performance of the GTX 1050 (1,733Gflops) and RX 460 (2,150Gflops) that represent entry-level dedicated GPUs. That's a big part of why most gamers end up running a dedicated graphics card.

> A quick upgrade to a dedicated graphics card can more than double performance.



AMD's Kaveri APU uses half the die space on graphics functionality.

Other factors include sharing system memory bandwidth. Even with two or three times as many GPU cores, without increasing the memory bandwidth, a lot of potential performance is lost. An HBM2 cache is a potential solution, and Intel has used eDRAM caches with its Iris products, but few desktop users are interested in improving integrated graphics when a quick upgrade to a dedicated graphics card can more than double performance.

Consoles are a different matter, where economies of scale come into play, and by targeting a closed platform, manufacturers can do more with less. The PS4's custom AMD processor uses about two-thirds of the die space on graphics, with the relatively slow Jaguar CPU cores relegated to one eighth of the die. The PS4 also uses GDDR5, with a 256-bit interface clocked at 5,500MT/s, with over four times the bandwidth of a dual-channel DDR4-2667 configuration, and the PS4 Pro should double GPU performance.

I'm eager to see what AMD does with the upcoming Zen APUs. Will it include a high-speed memory cache, along with substantially more GPU cores? It could, and I've seen rumors of an APU with potentially 1,024 Vega GPU cores—twice the number found in AMD's current top APUs. Combined with stacked memory (a single 2–4GB HBM2 stack, perhaps), AMD could end up surpassing the performance of its RX 460. Certainly, AMD has the expertise to pull this off, but I'm not convinced it will be enough to capture the interest of gamers, with price being a major factor. AMD might end up cannibalizing sales of its $100-200 graphics cards in order to sell more $100-200 APUs.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

MAXIMUM PC's TOP 7 THINGS FROM CES

7

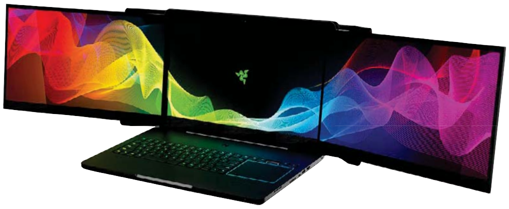
MSI AM4+ MOTHERBOARDS

With Ryzen launching in the first quarter of 2017, AM4+ mobos are coming thick and fast.

6

RAZER PROJECT VALERIE

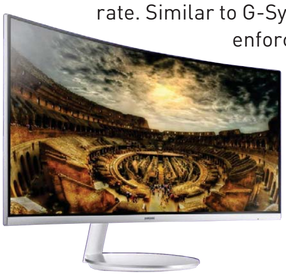
Although not to everyone's liking, this triple-screen gaming notebook touts a total resolution of 11520x2160.



5

AMD FREESYNC 2

The revolution of AMD's variable refresh rate. Similar to G-Sync, AMD is now enforcing standards including low latency and HDR.



4

LG NANO CELL TECHNOLOGY

LG is innovating on top of quantum dot by shrinking the pixel size down to a single nanometer to improve viewing angles, even beyond the limits of IPS and VA.

3

AMD VEGA GPU

The future's bright for AMD's next-gen GPUs. With HBM 2.0 and impressive compression tech, that 4K screen might have a use after all.

2

ASUS ROG SWIFT PG27UQ

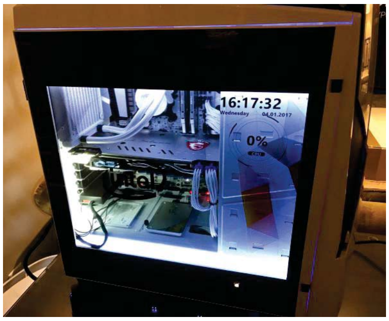
Meet the future of monitors—once graphics cards catch up. The PG27UQ combines 4K, 144Hz, G-Sync, and HDR in one sexy package.

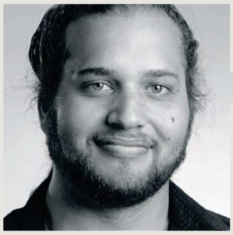
REPUBLIC OF GAMERS

1

iBUYPOWER PROJECT SNOWBLIND

The transparent LCD screen was first seen at Computex last year. Acting as a second display via HDMI, you can run anything you want on it.





Alex Campbell

OPEN SOURCE

Vulkan Can't Bring Games to Linux by Itself

FOR YEARS AND YEARS, being a Linux user meant giving up on the idea of playing top-tier games when they're released. For the most part, that's still true, but technologies are emerging that will make it easier for developers to distribute games for Linux. Unfortunately, these new-fangled technologies don't solve all of the underlying issues.

The first big thing that offers promise is the Vulkan graphics API, the spiritual successor to OpenGL. As an open API, Vulkan has promised a cross-platform API for developers who want to develop for Linux, Windows, Mac, and even mobile devices. (The API also shipped with support for the modern Wayland graphics server.) The API spec was published in early 2016, and hardware released during the year offered support for Vulkan. However, very few games offered support, with most released in 2016 opting for DirectX 11 or 12. Id Software's id Tech 6-powered *Doom* was a notable exception, showing the blistering-fast performance that Vulkan offered. Epic's Unreal Engine 4 also supports the API.

With a high-performance, modern graphics API available for Linux, one would thing there would be a tidal wave of AAA games for Linux. That wave hasn't come. A quick scan of a list of games with Vulkan support on Wikipedia shows eight games written for Vulkan. Only two of those (*Dota 2* and *The Talos Principle*) are available on Linux. (Id's *Doom* is curiously Windows-only, breaking from id's history of releasing shooters for Linux as well as Windows.)

Doomed? Actually, things are looking up for Linux gamers, but there's still much work to be done.

There simply aren't many games written for Vulkan yet, but given time, that will change. The percentage of those games that are released for Linux might not, however. The big reason developers shy away from Linux development is understandable. The market is minuscule compared to the number of gamers on Windows, and Linux presents a moving target in terms of libraries and drivers. Anyone who's broken something like Wi-Fi or Bluetooth support because of an update knows what I mean. That means a huge headache for very little return for a game dev shop. But there are a few new packaging technologies that aim to fix that.

> Linux is a moving target in terms of libraries and drivers; a huge headache for very little return for a game dev shop.

Universal Linux "container" formats are one of the most important new ideas for desktop users. They differ slightly from container technologies such as Docker, and aim to unify the Linux application distribution space.

These technologies promise to allow developers to package their apps with the libraries that they need. The formats allow them to stop chasing library updates, and distribute software images that are known to run on the vast majority of Linux systems without issue.

These formats also aim to unify distribution in the face of the fracturing caused by each distro's package management solution. Debian, Ubuntu, and Mint have deb; Fedora and openSUSE have RPM; Arch and Manjaro use tar.xz; Gentoo builds everything from source because why the hell not? This landscape is hell for software distribution (and creates a lot of work that volunteers have to do).

Unfortunately, the three new competing formats—flatpak, snap, and AppImage—suffer from the same problem, in that there's three of them. Hopefully, 2017 will see a clear winner pull ahead of the pack. But even if one does, and developers have a clearer and more stable platform to target, the chicken (penguin?) or the egg problem will likely persist: There aren't many gamers on Linux because there aren't many games for Linux, and there aren't many games for Linux because there aren't many gamers.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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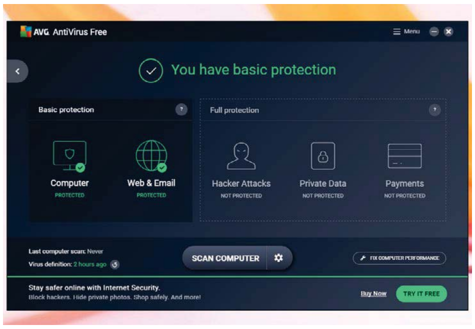
HEAD TO

BY **MATT HANSON**

AVG AntiVirus vs. Bitdefender Antivirus vs. Microsoft Defender

No matter how careful you are online, you can still be at risk of picking up a nasty virus or other malware. If you don't want to shell out for an expensive (and resource-hogging) antivirus app, there are plenty of free tools to keep you protected. Far from being cut-down and basic, even these free programs come with plenty of features to protect your PC. But are they too good to be true, and how do they compare to the built-in protection that Windows offers? We pit three of the most popular free antivirus tools against each other to find out.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NOT PROTECTED
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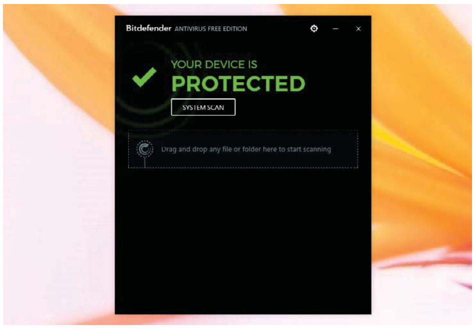
Buy Now
TRY IT FREE

You have basic protection

Last computer scan: Never
Virus definition: 2 hours ago

Stay safer online with Internet Security.
Block hackers. Hide private photos. Shop safely. And more!

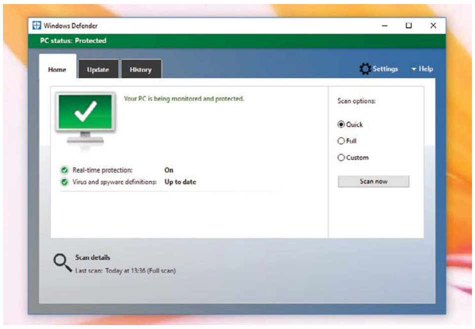
AVG AntiVirus also comes with a browser plugin for protection when surfing the Internet.


Bitdefender ANTIVIRUS FREE EDITION
SYSTEM SCAN

YOUR DEVICE IS PROTECTED

Drag and drop any file or folder here to start scanning

Bitdefender Antivirus is both speedy and highly effective at spotting nasties.


Windows Defender
Home
Update
History
Settings
Help
Scan now

PC status: Protected

Your PC is being monitored and protected.

Real-time protection: On
Virus and spyware definitions: Up to date

Scan options:
● Quick
○ Full
○ Custom

Scan details
Last scan: Today at 13:36 (Full scan)

Windows Defender is preinstalled with Windows, and never nags you to shell out for an upgrade.

ROUND 1

Features

Defender has virus, malware, and spyware detection and removal. Real-time protection monitors downloaded files. There's no firewall. Cloud-based protection defends against threats identified on other users' PCs. It comes preinstalled, with no ads or pop-ups nagging you to upgrade.

The free version of AVG features virus, malware, and spyware protection, and real-time security updates. Unlike Defender, it comes with a plugin to protect you from unsafe links, downloads, and email attachments. A gaming mode (that cuts down on resources used) is welcome, but if you want firewall or phishing protection, you must pay.

Bitdefender offers similar features as AVG, plus comes with Autopilot mode, which configures security settings on the fly, enables automatic updates, and more, with no annoying pop-ups, but AVG's gaming mode gives it the edge.

**Winner:
AVG**

ROUND 2

Ease of Use

We want our antivirus app to be unobtrusive, and keep us protected with the minimum of fuss. In that regard, Windows Defender has a huge advantage, as if you're running a recent version of Windows, it is already installed and configured.

Downloading and installing Bitdefender is straightforward, scanning your PC during the process. The interface is streamlined and easy to understand, and the Autopilot mode means you can leave it alone to get on with protecting you. To scan specific files, just drag and drop them.

AVG's interface has simple indications letting you know if your PC is protected, and a big button to scan your system. It's not as hands-off as the others, but installation is simple. You're encouraged to install a browser plugin to protect you while online, but it tries to change your homepage and default search engine, which we don't like.

**Tie:
Windows Defender and Bitdefender**

HEAD

ROUND 3

Virus Scanning

In the latest AV Comparatives benchmarks (which are carried out by an independent company), Bitdefender blocked 1,618 out of 1,619 test cases successfully, with a protection rate of 99.9 percent. AVG didn't catch quite as many, with 1,612, and 99.6 percent. Windows Defender caught 1,570 test cases, for a protection rate of 97 percent. That's still high, but not quite as good as the other two AV products on test.

AV Comparatives also tested the programs for false flags—these are safe files or websites that are incorrectly identified as harmful, and blocked by AV programs. Both AVG and Bitdefender passed the tests with no wrongly blocked files or websites, but Windows Defender incorrectly blocked 23 cases. While it's a close call between AVG and Bitdefender (with Bitdefender just edging a win), Windows Defender's performance was rather disappointing.

**Winner:
Bitdefender**

ROUND 4

Scan Speeds

On our test machine, Windows Defender completed a Quick Scan in one minute, scanning 11,288 files. We then performed a deeper scan on a full 100GB hard drive, which completed in 26 minutes, 42 seconds. Next up was Bitdefender, and the initial Quick Scan took just 49 seconds. With the free version of Bitdefender, scan choices are a bit limited, so we dragged and dropped the entire 100GB folder on to the program to scan. That took just seven minutes, 10 seconds, which is a lot quicker than Windows Defender.

AVG doesn't have a Quick Scan option, though it offers lots of ways to configure scans, so they only check the bits of your PC you want. The default is a full, deep scan. This is advisable with all AV products, to make sure your PC is completely safe. However, with our custom scan of the 100GB hard drive, it took 9 minutes, 48 seconds. Much faster than Windows Defender, but not as quick as Bitdefender.

**Winner:
Bitdefender**

ROUND 5

Resource Use

Antivirus software can be very resource hungry. With Microsoft's knowledge of Windows, you'd think Defender would have an advantage here. While performing a full scan, it took up a peak of 275MB of RAM, with CPU use (a powerful quad-core Intel Core i7) hovering around 54.6 percent. When not in use, it used 152MB of RAM.

Bitdefender was much more resource-intensive. When idle, it used around 180MB of RAM, but when scanning, it had peaks of 780MB RAM use (though around 400MB for most of the scan time), and CPU usage spiking at 98 percent, averaging about 70 percent. The price to pay for such fast scanning.

Meanwhile, we were very impressed with the impact of AVG. At idle, the software takes up 130MB of RAM, while in use it only takes up around 160MB. Better still, CPU use never went higher than 14 percent—a far cry from the stress Bitdefender puts the PC under.

**Winner:
AVG**

And the Winner Is...

Every one of these AV tools has something going for it, be it Windows Defender's convenience, Bitdefender's excellent detection rate, or AVG's speed and lightness. If you go with Bitdefender, you can be sure your PC is as well protected as possible for a free program, and if you just stick with Windows Defender, you'll at least be protected against the majority of threats.

However, the overall winner of these tests is AVG. It comes with plenty of features, has an excellent detection rate, and decent scanning speeds. What we really love, though, is how few resources it takes up when running in the background, or even when scanning your computer. It does a great job of protecting your PC, while having almost no impact on performance—like all good AV products, you'll hardly know it's there.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Workstation Power
> Mixing Memory
> Jumping to X99

Workstation Power

Hi Doctor. My son is a 3D digital design student at Rochester Institute of Technology (RIT). We purchased a Lenovo P700 system for his design work and, of course, gaming. He uses applications such as Maya, RealFlow, and Adobe's CC suite.

He's having an issue setting up his hardware to reduce the time it takes to render projects in Maya—they take as long as 30 hours to complete. I don't think adding more memory will help, and he's already running dual Xeon processors, with a pretty good graphics card.

We looked for ways to better utilize both processors, but can't figure that out. He also thinks a second graphics card might help, but can't find documentation supporting his hypothesis. Any ideas you have would be greatly appreciated.

–Dave Fantauzzo

Lenovo's ThinkStation P700 may require higher-end CPUs for optimal rendering performance.

THE DOCTOR RESPONDS: The Doc is well versed in matters of hardware, but less familiar with Maya, and the resources its renderer exploits. To get you the best answer, the Doc went to his friends at Puget Systems in Auburn, Washington, who test and write about optimizing configurations for workstation applications. Matt Bach, in Puget's lab, sent over the following guidance: "If faster render times from Maya are your primary concern, the solution isn't quick or easy. You are correct that more RAM likely won't help (32GB is typically plenty), and as Maya uses a CPU-based rendering engine, upgrading the GPU won't improve render times either. The weakest link in your son's dual-Xeon workstation is the CPUs themselves. Two Xeons can work very well for rendering, as they scale nicely with higher core counts, but the E5-2609 v3 is only one step up from the lowest-end CPU of that generation. Upgrading a dual-Xeon setup isn't as cheap as adding RAM, but it's the only thing that will help significantly.

"For rendering, the Xeon E5-2630 v3/v4 is usually the lowest-end dual-CPU config we recommend to one of our customers. Compared to the E5-2609 v3s your son has today, a pair of E5-2630 v3s could be expected to drop that 30-hour render to 17 hours or so. You could use a cheaper CPU, but anything lower than the -2630 will typically be outperformed by a 6- to 10-core 3GHz-plus single-CPU system, which is also more affordable. If you have the budget to go higher than the E5-2630, a quick rule of thumb for rendering is to use Xeon CPUs that end in a 0 (-2630, -2640, -2660, and so on).

"Keep in mind that many of the other tasks you mentioned (gaming, Maya modeling, and all Adobe software) do not work well with dual-Xeon systems. There is extra processing overhead when you have two physical CPUs, and unless the software is good at utilizing multiple cores at the same time—as rendering is—you often get better performance with one CPU than with two. In fact, for gaming and modeling/animation, four cores running at high clock rates yield much better performance."

Mixing Memory

Dear Doctor, When it comes to memory, if I'm using the same brand and speed, does it matter if I install two 16GB modules with a CAS rating of 14 and two 4GB sticks at CAS 16? Both would be DDR4-3200. Or would a slower data rate at CAS 12 be better? I'm doing some gaming,

↘ submit your questions to: doctor@maximumpc.com surfing the net, and watching old *Tarzan* movies. If I overclock, it'll be conservative.

I also have a Samsung M.2-based boot drive and a Samsung SSD for user data. If I use an external SSD for downloading Internet content, and that content is infected with a virus, would only the portable drive be affected, or could the contagion spread to other devices? A $60 external drive lost to cooties would be far better than the permanent drives.

If this helps, I plan on buying a Core i7-6700K, an MSI Gaming M7 or Asus Maximus VIII Hero motherboard, a Corsair H110i GT cooler, a Samsung 850 EVO 500GB M.2, a Samsung 850 EVO 1TB, an MSI GeForce GTX 1080, and a Be Quiet! Dark Base 900 chassis. **–Ray Nimeth**

THE DOCTOR RESPONDS: Let's start with your memory question. The answer isn't straightforward because it depends on a number of variables. First, there's your motherboard's BIOS. Depending on how the firmware was written, it might choose the slowest common memory settings, the memory settings from a preset priority list of slots on the board, the serial presence detect (SPD) settings from a random module, or it could refuse to boot when presented with conflicting SPD information. The memory chips on those modules could also be incompatible due to different densities or capacities.

So, there's a lot that could go wrong—if you have the option to avoid mixing kits, take it.

If you already have them both, try installing the modules in alternate slots, so that the kits each populate one channel. Check your manual for guidance on where to put the higher-capacity modules. Should your system boot successfully at low baseline settings, dial in manual settings for the data rate, CL timings, command rate, and voltage (that is, don't use XMP). Specify the lower of the settings between both kits.

Should you run into trouble booting up, try resetting the BIOS settings to default. If the issue persists, you're likely out of luck. Don't be surprised if this is the case; it could be that the capacity differences between 16GB and 4GB modules are simply too great.

In regard to your external drive question—yes, any virus on one drive can potentially affect other drives as well.

The Right Connection

Hello, I'm a long-time subscriber, going back to the days of *Boot*. In the January 2017 issue, editor-in-chief Tuan Nguyen's Lab Notes article "Short Circuits" intrigued me, as I recently built a new system. I double-checked and verified that I was using both the CPU_FAN and CPU_OPT headers, which Tuan warns against doing.

I've had the system for a month and have had no problem whatsoever. It consists of a Core i5-6600K attached to a Gigabyte Z170X-Gaming 7 motherboard, with a Corsair H60 CPU cooler. The radiator fan is connected to the CPU_FAN header, while the pump is connected to CPU_OPT. I left it as-is for the moment because, like I said, zero issues. Thoughts? **–Mike H.**

THE DOCTOR RESPONDS: Tuan was having issues with an Asus board; that company's support folks advised against using both headers concurrently to avoid the problem he encountered.

The Doc consulted Gigabyte about your motherboard, and was told that the CPU_FAN and CPU_OPT headers can be used together without an issue. CPU_FAN is either for a heat sink or radiator fan that can ramp up and down based on CPU temperature; CPU_OPT is an additional header that can provide 100 percent power all the time to the pump. Each has its own IC to control amperage limits. You're in the clear.

Reinstalling Win 10

I have a Lenovo laptop that came with an OEM copy of Windows 8 and a UEFI firmware. I upgraded to Windows 10 on my own, and it was working well. Unfortunately, the OEM diagnostic software still thinks I'm using Windows 8.

I'd like to remove everything and reinstall from a Windows 10 Home disc. However, it is my understanding that because the laptop has UEFI, it requires the original OEM partitions to boot. In other words, I can't delete the OEM partitions and software before performing a full reinstallation.

Is there any way around this requirement, and how does one get a laptop with no operating system to perform its own installation? **–Gerald Gibson**

AMP-UP Audio
Sound Core3D
G1 GAMING
GIGABYTE
GIGABYTE GA-Z170X-Gaming
USB 3.1 HDMI Intel GbE LAN UEFI DualBIOS
32Gb/s M.2
DDR4
Socket 1151
ErP Ready

Gigabyte's Z170X-Gaming 7 supports simultaneous use of its CPU_FAN and CPU_OPT headers.

THE DOCTOR RESPONDS: Updating an older system to Windows 10 sometimes requires a BIOS/UEFI update. For anyone else considering this, depending on how old the laptop is, it may or may not support Win 10, or you may run into driver limitations.

That said, if you have an optical disc drive, Windows 10 Home media, and the key, there should be nothing preventing you from starting afresh. Update the UEFI by downloading the latest version from Lenovo's website. Pop the disc in your drive, and ensure your firmware is configured to look there first upon boot. Or, visit http://go.microsoft.com/fwlink/?LinkId=691209 to download Microsoft's media creation tool.

Jumping to X99

Hey, Doc! I got my hands on a Core i7-6850K for a great price, and I'm wondering whether I should make the jump to X99? I still need to buy a new motherboard and RAM.

I have a Core i7-4790K on the Z97 chipset, and that's working fine for me, but I'd like to take advantage of the additional cores, PCIe lanes, and support for full-speed M.2 drives. I want to get the most from my ROG Swift PG279Q, a task I suspect may require two GPUs.

However, I've heard that the LGA-2011 v3 interface won't be used for Skylake-X and Kaby Lake-X. And some of the new Z270 boards that are coming out look quite tempting as well, especially with their support for Intel's upcoming Optane tech.

I mostly do digital drawing and gaming, though I do use virtual machines from time to time. Do you think I'd be better served making the jump to the enthusiast X99, or finding some other use for my new CPU and sticking with consumer platforms like Z270 or (gasp) AMD's Ryzen? **–Jordan S.**

THE DOCTOR RESPONDS: The Doc wouldn't jump to X99 for gaming alone; your fast quad-core CPU is fine for that. Plus, a single GeForce GTX 1080 or 1070 will drive your QHD display well enough in the latest games. Even if you do crave more graphics performance, two x8 slots are plenty for CrossFire or SLI. But virtualization does benefit from lots of cores and cache. That could be reason alone for you to make the switch, if the workload is important enough. ⏻

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CORSAIR
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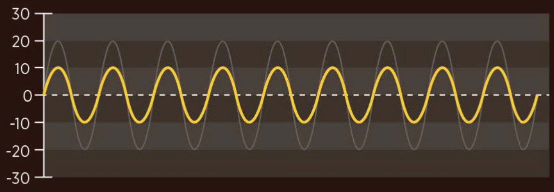

🟨 RMi: Represents < 20mV of ripple at full load on RM1000i

▨ Brand X: Represents 40mV of ripple at full load on other leading brand 1000W PSU

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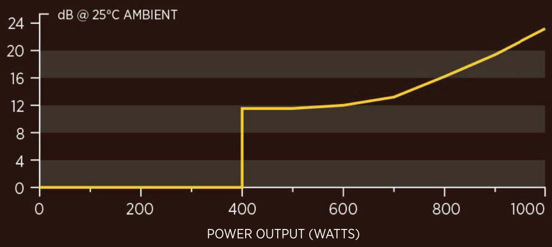

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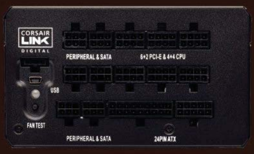
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BUILD IT BETTER

BIG-SCREEN DEBUT

Never before has the high-end PC monitor market been so vibrant and innovative. Allow *Jeremy Laird* to help you solve this particular paradox of choice

ProArt
/ISUS
HDMI

A WINDOW INTO YOUR COMPUTING WORLD. That's what a PC monitor is. The question is, do you want your view to be a miserable, letter-box glimpse, or a broad, expansive, and liberating vista?

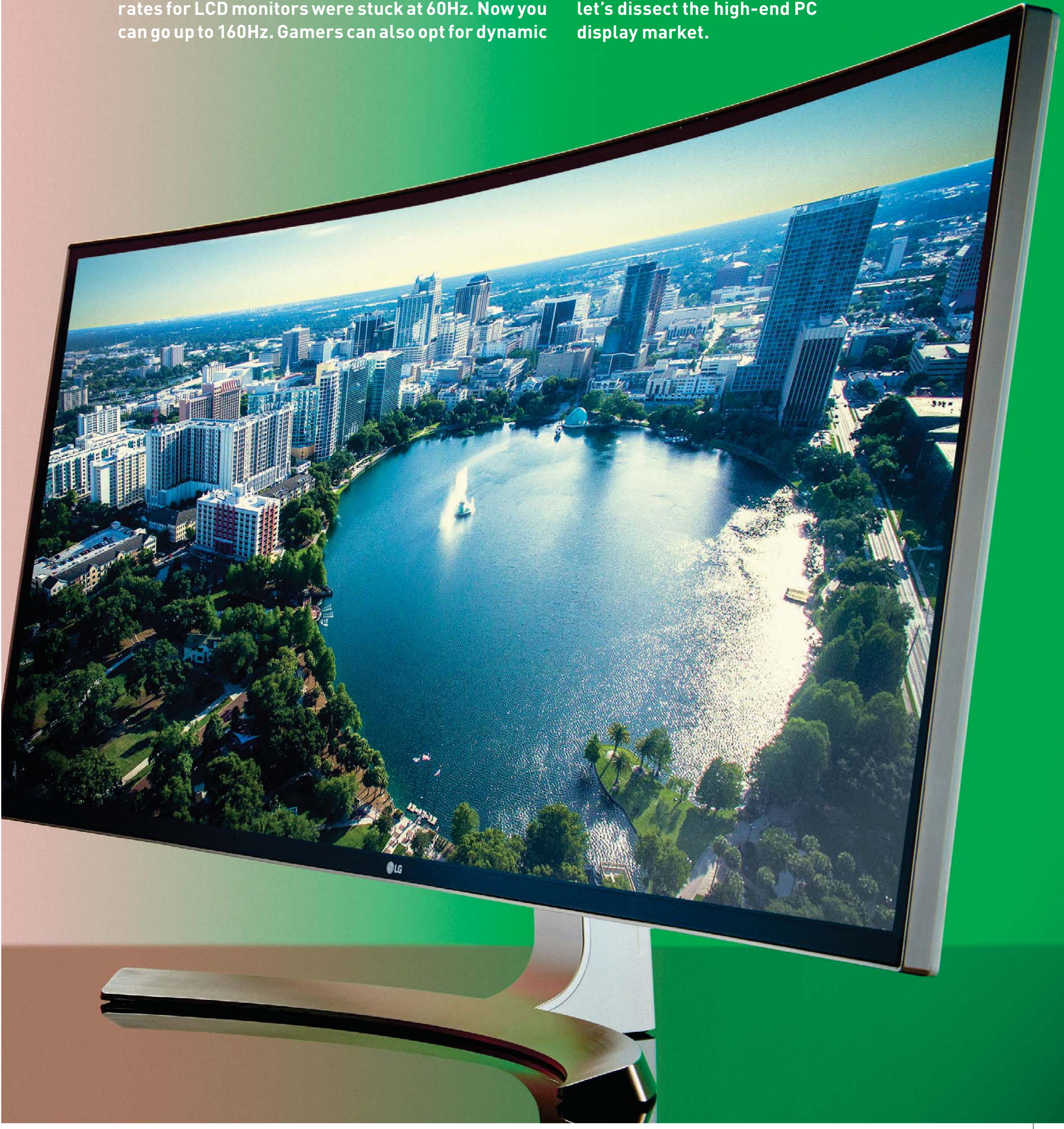
OK, that's a loaded way of posing the problem of screen choice. It ain't all about size. In fact, at the high end, generous proportions are a given. So it's all the rest that you need to worry about: panel type, native resolution, and pixel pitch, for instance.

But that's just the basics. The PC monitor market is more complex than ever. That begins with a much broader choice of shapes and sizes. You can go seriously big these days. You can also go seriously wide, thanks to 21:9 aspect ratio panels. And you can go curved for a wrap-around experience.

Meanwhile, several spectacular new image-enhancement technologies have emerged over the last two years. It wasn't that long ago that refresh rates for LCD monitors were stuck at 60Hz. Now you can go up to 160Hz. Gamers can also opt for dynamic refresh rates synched with the output of their video card. Then there's the widespread adoption of far higher resolutions, such as 4K or UHD.

Even more recently, there's been a revolution in colors and contrast. HDR, or high dynamic range, is the latest technology to hit the display market. It's already pretty much taken over the high-end HDTV segment. Now it's beginning to assimilate monitors. However, the process will be more complicated on the PC, as if the practicalities of implementing HDR weren't already complex enough. Point being, you'll be able to pick and choose between various aspects of what has become known as HDR.

An example is quantum dot technology. It's a color enhancement feature that isn't strictly associated with increasing dynamic range, but it's part of the broader HDR toolkit that's finding its way into PC monitors. So, let's dissect the high-end PC display market.



LET'S TAKE A TOUR around the recent history of the high-end PC monitor. Remember when a 24-inch widescreen monitor with a 1920x1200 native resolution constituted high end? We're thinking 2004, and the Dell 2405FPW. You can get something close to that for about 100 bucks today. Incredible.

About three years later, Dell shook things up again with the 3007WFP, a 30-inch 2560x1600 beast that was so spectacular at the time, it was hard to imagine anything bigger. But a further five years down the road in 2017, and the 3007 is toast.

Screen tech is advancing at breakneck speed. One moment you're marveling at the latest superwide curved monitor, the next you're having your entire field of view saturated by staggering HDR visuals courtesy of a 55-inch UHDTV, and every monitor you've ever used before suddenly seems tiny.

But let's not get ahead of ourselves. Choices must be made. You can't have everything in one monitor. For instance, let's say you wanted a 4K screen with 160Hz refresh, and 40-inch-plus diagonal. It can't be had. So, you need to be clear on your priorities.

Let's look at gamer-centric tech, including ultra-high refresh rates. High refresh on the desktop is nice. It's hard to go back to a 60Hz panel once you've experienced 120Hz-plus. But, arguably, anything above 120Hz for the desktop is redundant. Adaptive refresh technology, including Nvidia's G-Sync and AMD's FreeSync, is even more gamer-centric. If you don't game much, you can probably ignore it.

Now let's move on to size and shape. Your options are extensive and the choice subjective. It is also intimately related to native resolution. For starters, bigger isn't always better. The UHD or 4K pixel grid of 3840x2160 sounds impressive. On a 32-inch monitor, it gives a nice, tight pixel pitch, crisp fonts, and loads of detail. On a 50-inch panel, it's a whole different ball game. At least, it is at normal PC monitor viewing distances. You can move further away with a larger panel, but if the apparent size is then the same, what's the point? Likewise, is a screen hooked up to a PC while you sit on a couch 15 feet away a monitor or a TV? Similarly, it's possible to go too big in terms of panel viewability. Beyond 40 inches, a screen situated at conventional monitor viewing distances requires a whole lot of head craning.

That said, many people who thought 30-inch panels were too big 10 years ago are probably happily running 32-inch or 34-inch monitors today. What feels unwieldy at first, can soon make reverting to a smaller screen seem restrictive. On a similar note, where do projectors fit in? A projector can never be a direct replacement for a PC monitor, yet nothing can compete with their sheer cinematic scale.

POINTS OF VIEW

Aspect ratio is another consideration. Superwide 21:9-aspect monitors are gaining traction. They're fantastic for movies. They work great with games. They can be thoroughly ergonomic for viewing multiple documents or web pages at the same time, too. But they're also restrictive in terms of vertical resolution and desktop space. So, while you may be able to view documents side by side more easily, your view of each is more limited, which means more scrolling. The 21:9 aspect is also distinctly sub-optimal for standard 16:9 HDTV video content.

Curved versus flat is yet another geometric conundrum. In our experience, this is a question of personal preference. Some people love curved screens, others think they look ridiculous. We argue that the bigger a screen is, the more sense a little curve can make. But just remember, not all screens sport the same curve. Some are curvier than others. So, head down to your local store, and get a feel for the various radii of curve on offer.

All of which brings us to plain, old image quality. Partly, that's a

Above from left to right: The Asus PA329Q has advanced quantum dot technology, but it's the purist's choice.

The Dell UP3017Q is one of the first OLED PC monitors to arrive—but it costs a fortune.

LG's 38UC99 is the latest superwide curved-screen wonder.

This HDTV is big and beautiful, but do you really want a 50-inch screen as a PC monitor?

Below: 4K tech has now come to projectors, too.

question of panel choice. At this end of the spectrum, it's unlikely you'll be considering a TN panel, though some gamers prefer TN at any price, thanks to its superior pixel response. For everyone else, it's a choice between IPS and VA panels, plus closely related variants thereof, such as Samsung's PLS tech, which is essentially IPS by another name.

Ultimately, the traditional divisions here remain. IPS is the best choice for color accuracy and viewing angles, while VA delivers the best contrast and color saturation. So, you'll want IPS for a super-precise pro-style monitor, or VA for the ultimate in visual pop and punch. That said, those traditional categories are blurring. An IPS display with quantum dot backlight technology can have colors with even more pop than VA with a conventional LED backlight.

What's more, the emergence of HDR, or high dynamic range, technology is complicating matters, a subject we covered in depth in our January issue. Long story short, HDR uses technologies, including local backlight dimming, to dramatically increase the range of brightness a screen can display. The new HDR standards also bring with them an expansion in color spaces, and support for up to 12 bits of color per channel—in the past, even high-end monitors have been limited to eight bits per channel.

A true HDR monitor is capable of much greater highs and much lower lows than a conventional screen. The results can be spectacular, but HDR may not be for everyone. A 32-inch 4K IPS monitor with quantum dot technology is a very different proposition from something like a large 4K TV with HDR capability, to the point where it's more a case of what fits your needs than necessarily determining which is better. You pays your money. You takes your choice. And the end result is a stunning screen.

WHEREFORE ART THOU, OLED?

It feels like OLED has been the next big thing in monitor tech for about a decade. It's been one of those technologies that seems to always be just around the corner, but somehow never arrives.

OLED, or Organic Light Emitting Diode, tech has actually been successful on the small scale of smartphone displays for several years. Scaling the technology reliably and affordably for big displays has proven more difficult. However, the major brands in the HDTV market went big on OLED at CES earlier this year. What's more, the first laptops with full OLED displays have now gone on sale, including the Lenovo ThinkPad X1 Yoga and the latest Alienware 13.

Strictly speaking, the first OLED PC monitors have also arrived. The Dell UP3017Q delivers an OLED panel in a 30-inch 4K form factor. Problem is, it's a $5,000 screen. OLED, then, isn't exactly mainstream. But it will be worth the wait when it does become more affordable. That's because, when you get right down to it, LCD is a fundamentally borked technology on which to base a large, full-color display. When you sit in front of the latest 4K HDR LCD TV, that's easy to forget. The world's display engineers have done an amazing job of compensating for the obvious flaws in LCD technology. But the advantage OLED has, by virtue of each pixel being its own light source in terms of contrast, viewing, and response, is simply too much. Already, OLED beats LCD hands down in many areas, and it's still a nascent technology. A decade from now, OLED displays will be making anything with an LCD panel look utterly ancient.

Lenovo's Yoga X1 is one of the first vaguely affordable PCs with an OLED display.

AOC U3477PQU

Six hundred bucks, but still a bargain

WHAT TO MAKE OF AOC'S slick, superwide U3477PQU? It comes down to your point of view. If you're a serious player in the true high end of the monitor market, it's not going to be on your radar. But if you want to get a slice of the high-end action at a more attainable price, slap it on your shortlist.

It all starts with the 34-inch LCD panel. It's a proper IPS item. It's also 34 inches across the diagonal, and packs a 3440x1440 pixel punch. For most mere mortals, that's plenty. The 21:9 aspect ratio also adds an element of the exotic. AOC has done a nice job of giving the chassis and stand a quality consumer electronics vibe, too.

Image quality doesn't disappoint, either. It's more vibrant than the more expensive LG 38UC99, even if it can't match the quantum-dot brigade with their eye-popping colors. It doesn't suffer from any major accuracy flaws either. There's a little banding when viewing gradients, but it's subtle. The black and white scales show virtually no evidence of compression, so the factory calibration is solid. It's IPS, so the viewing angles are great, and both black levels and contrast are good. It can't compete with a VA panel or an HDR screen with local dimming for really inky blackness, but that's inevitable.

Similarly, you have to be realistic about the overall feature set at this price. You're not going to get 10- or 12-bit color support, for instance. In strict terms, that limits your content mastering options. Nor can you expect the U3477PQU to be loaded up with the latest gaming-centric goodness. It tops out at a 60Hz refresh, it doesn't support adaptive synching, and it's completely flat.

That said, the U3477PQU is far from without gaming merit. AOC gives you four levels of pixel overdrive, so you can decide if you want to minimize blurring by ramping the overdrive to the max, in return for some inverse ghosting. That 34-inch 21:9 panel, with its 3440x1440 grid, is a very nice compromise for real-world gaming, too. It's big enough to feel cinematic, and the pixel count provides lots of detail without presenting your GPU with a huge overload.

You could make a similar argument for the U3477PQU as a day-to-day productivity monitor. We'd prefer 32-inch 4K for the superior pixel pitch and additional desktop real estate. The 21:9 aspect ratio can also create its own problems: 16:9 TV content looks silly (and small) framed by thick black bars either side, for instance. Those 1,440 pixels of vertical resolution will feel constraining for some. But at this price, it's a decent compromise if you want a screen that can turn its hand to a little bit of everything, and look slick in the process.

VERDICT
7

AOC U3477PQU

⊞ **A NEW HOPE** Nice all-round package for the money; quality IPS image quality; slick chassis.

⊟ **PHANTOM MENACE** Lacks high refresh and frame synching; color capabilities limit content production support.

$616, www.aoc.com

SPECIFICATIONS

Panel Size	34-inch
Native Resolution	3440x1440
Pixels Per Inch	110
Panel Type	IPS
Max Refresh	60Hz
Response	5ms
Display Inputs	1x DisplayPort, 1x HDMI, 1x DVI, 1x VGA
Connectivity	N/A
VESA Mount	100 x 100mm
Warranty	Three years

ASUS PROART PA329Q

Time to put away the big boys' toys

SUPERWIDE 21:9 aspect screens with crazy curves? Wall-sized UHDTVs masquerading as PC monitors? Gaming gimmicks such as adaptive sync and 160Hz refresh? They're all very well, but it's time to put away the big boys' toys and get serious. Enter the new ProArt PA329Q, Asus's shot at a lasting monument to visual precision.

It isn't big by high-end standards. It's just 32 inches. But it is 4K, which has implications for pixel pitch and sharpness. As its name suggests, it's aimed at serious productivity, therefore the core technology is IPS, with added color-fidelity chops.

In terms of color reproduction, that includes 10-bit per channel support, along with a 14-bit look-up table for precision calibration. But what marks the PA329Q out as cutting edge is the addition of quantum-dot backlight enhancement for even greater color dynamism. The result is 100 percent coverage of the Adobe RGB color space. Asus also claims that factory calibration guarantees a sub-two Delta E color space.

The bottom line is that this display will enable you to properly master content for HDR compliance, including the Rec. 2020 video gamut. The PA329Q's physical bearing reflects its pro remit, too. There's a pleasing quality to the chassis and stand, the latter being fully adjustable, including rotation to portrait mode. While the overall feel is robust, it's far from chunky or old-fashioned, thanks to a very slim bezel. What you don't get is a curved panel, zany refresh rates, frame synching, or crazy levels of pixel overdrive. It's all about precision.

Fire her up, and initial impressions are glorious. The PA329Q is supervibrant, but without that uber-saturated look that many TVs go for in order to achieve superficial punch. Think of it as both power and control when it comes to colors. The viewing angles are pretty much immaculate, too, and the anti-glare coating is superclean and free from grain or sparkle. Plus, there's the razor sharpness due to that tight pixel pitch.

The basic calibration is bang on, with flawless detail in white and black scales, and visually perfect gradients. The default 6,500K color temperature is a little warm subjectively, and the IPS panel can't compete with the latest VA screens for contrast and black levels. Likewise, support for a higher refresh rate would be nice, but that's limited by display interface bandwidth.

In all other regards, this is a screen with which you could have a long and meaningful relationship. The advent of OLED tech notwithstanding, it's easy to imagine the PA329Q still looking stunning in five years. It ain't cheap, but it is a good investment.

VERDICT

9

KICK ASS!

Asus ProArt PA329Q

➕ **PRECISION TOOL** Extremely high fidelity IPS panel; impressive color capabilities; superfine pixel pitch.

➖ **NOT SO COOL** Not exactly cinematic in scale; requires a fairly serious investment; not ideal for gaming.

$1,249, www.asus.com

SPECIFICATIONS

Panel Size	32-inch
Native Resolution	3840x2160
Pixels Per Inch	127
Panel Type	IPS
Max Refresh	60Hz
Response	5ms
Display Inputs	4x HDMI, 1x DisplayPort, 1x Mini DisplayPort
Connectivity	USB, card reader, 3.5mm audio
VESA Mount	100 x 100mm
Warranty	Three years

BENQ PD3200U

An LCD panel for old-school purists

SPARE A THOUGHT for the BenQ PD3200U. While the Asus ProArt PA329Q struts about, flaunting its quantum dot-enhanced colors, the PD3200U must make do with an LED backlight. However, this otherwise similar BenQ monitor has its own appeal.

Mostly, that comes down to price. The BenQ rocks in at just under $900, while the Asus sports a much heftier $1,250 sticker. Both share very similar core specifications and form factor: 32 inches of precision IPS panel, and the 3840x2160 pixel grid that denotes full-on 4K action. Like the Asus, the BenQ offers 10-bit per channel color, too.

The PD3200U also cuts a similar dash on the desktop. It aims for a sober suit that majors on quality and functionality, including a fully adjustable stand that supports rotation to portrait. That said, it doesn't have quite as pleasingly slim a bezel as the Asus. From there, you begin to see where BenQ achieves some cost savings.

The PD3200U delivers 100 percent of the smaller sRGB color space, rather than the more fulsome Adobe RGB gamut the Asus notches up. Similarly, where the Asus is fully Rec. 2020 compliant, the BenQ only musters the FullHD Rec. 720 color space.

In practice, however, the BenQ doesn't feel like you make much of a trade-off. It really is beautiful, with subtle yet vibrant and pleasing colors. The out-of-the-box calibration is mostly very good, too. Black and white scales show no signs of compression, and if anything we prefer the BenQ's default color temperature. It's bang on. That said, a whiff of banding in gradients is visible. Similarly, the anti-glare coating suffers from just a touch of graininess.

Move the frame of reference beyond its Asus nemesis, and it's down to personal preference. On the one hand, it blows away all the larger screens in terms of crispness, detail, and accuracy. There's no substitute for more pixels per inch. On the other, it's not gaming-centric. There's no high refresh rate, no frame synching, no HDR or mega-bright backlight, or incredible contrast ratios. Its pixel response is merely adequate, too. And at 32 inches, it's not going to fill in as a home cinema screen.

However, most of those complaints are largely beside the point. This isn't a gaming monitor or a home cinema screen, even if it can turn its hand to those tasks. Instead, it's a conventional PC monitor that majors on productivity, and delivers an upscale experience for a reasonable price. The Asus PA329Q may be the superior monitor, but it's also more expensive. If you can't quite stretch to the Asus, you'll be grateful BenQ is offering this more affordable option.

VERDICT 8

BenQ PD3200U

+ IVY LEAGUE GRAD Lovely IPS panel; supercrisp 4K pixel pitch; competitive pricing.

− HIGH SCHOOL DROP-OUT Modest overall proportions; can't compete with the best on color space.

$899, www.benq.com

SPECIFICATIONS

Panel Size	32-inch
Native Resolution	3840x2160
Pixels Per Inch	127
Panel Type	IPS
Max Refresh	60Hz
Response	4ms
Display Inputs	1x HDMI, 1x DisplayPort, 1x Mini DisplayPort
Connectivity	USB, 3.5mm audio
VESA Mount	100 x 100mm
Warranty	Three years

EPSON POWERLITE 5040UB

Kinda 4K. Definitely a projector

WANT A REGULAR 4K monitor? Not a problem. You can have one for 300 bucks. Hell, you can get a 40-inch 4K TV for even less than that. Prices really have plummeted. But projectors? Not so much.

Projectors always have been a niche market. Volumes are lower, prices higher, innovation not as brisk. It also doesn't help that one of the major projector technologies, Texas Instruments' DLP, remains locked down under patent protection. The likes of Intel flirted with shaking things up with LCOS (Liquid Crystal on Silicon), then decided it wasn't worth the hassle.

Anyway, just as 1080p FullHD was slow to make the move into the projector market, so it is with 4K or UHD. But it is happening. There's been a number of mega-money 4K projectors available for a while, but now the first consumer models are appearing. They're not cheap—the Epson PowerLite 5040UB rocks the scales at $2,999, but it's not some $20,000 monster aimed at professional installations.

There is a catch: It's not true 4K. In fact, it's a triple-LCD projector, with a native resolution of 1920x1080, and what Epson calls "4K enhancement." The details involve what's known as "pixel shift." The idea is simple: First, project the native 1920x1080 grid, then use the optics to shift the grid up and to the right by half a pixel, and fire again. Rinse and repeat, except so fast the eye can't see the oscillations, and add clever image processing to smooth everything out.

The result isn't true 4K. The math works out to around four million pixels, where 1080p is two million, and 4K is eight million. But from your video card's perspective, the projector accepts a 4K input. But what about your eyes? Without question, it's a huge leap over standard HD. The crispness and detail is on a whole new level. If you'd never seen a true 4K projector, you'd probably believe this was the real 4K deal. Even if you had, you'd probably be fooled. The step up to true 4K isn't as dramatic as the step from FullHD to this pixel-shift option.

It's a very nice projector in general terms, too. LCD technology has come a long way, and the contrast and colors are superb. The full-feature optics are remote-controlled, which makes the 5040UB a cinch to set up, even when installed on a ceiling mount or similar. It's virtually silent in operation, too. On the other hand, it's physically a big ol' box, and the usual projector limitations apply. You can't just stick it in any old room and use it any old time. Ambient lighting conditions need to be managed. But for gaming and video on a truly cinematic scale, nothing else here comes close.

VERDICT

8

Epson PowerLite 5040UB

⊞ **CINEMATIC** Far more crisp and detailed than a 1080p beamer; super all-round image quality.

⊟ **IDIOSYNCRATIC** Not actually true 4K; still pretty pricey; physically it's a big beast.

$2,999, www.epson.com

SPECIFICATIONS

Projector Type	Triple-LCD
Resolution	1920x1080 with 4K pixel shift
Brightness	2,500 lumens
Contrast	1,000,000:1 (dynamic)
Refresh	120Hz (1080p), 60Hz (4K)
Throw Ratio Range	1.35–2.84
Color Processing	10-bit
Other	3D support, lens shift with remote control and memory function
Warranty	Two years (lamp 90 days)

LG 38UC99

Superwide? Make ours extra large...

AS YOU PLAN A GROUP TEST, and the slots fill up, there's usually one entrant that stands out. One that feels like a winner in the making. This time, it's LG's new 38UC99.

As a 21:9 aspect ratio panel, that's surprising. After all, superwide screens are an acquired taste. But with the 38UC99, LG has hammered the main shortcoming of such screens—limited vertical resolution and desktop space—into the stands.

The first 29-inch 21:9 LCD monitors managed just 1,080 vertical pixels. Then a new 34-inch generation arrived, and upped the ante to 1,440 vertical pixels. Good enough for most, but not quite enough for everyone. Now LG has ramped the 21:9 category up to 38 inches and 1,600 vertical pixels. That's gotta be enough, surely?

The rest of the specs look promising, too. The overall pixel grid is 3840x1600, so there's oodles of elbow room. The panel tech is IPS, and there's 10-bit color support enabling 99 percent of the sRGB color space. LG has also added a few extras in the form of 75Hz refresh when used in concert with FreeSync adaptive frame rate technology.

That still means there's a number of cutting-edge features missing. You don't get really high refresh rates, HDR support, a backlight with quantum dots, or any of that jazz. Of course, with very little HDR content available, it's questionable how relevant that all is. Instead, the 38UC99 seems to major on what you might call traditional monitor qualities. Plenty of pixels. A high-quality panel. High-fidelity color support. A nice, enveloping panel curve. That kind of thing. On paper, it's our kind of screen.

As soon as you fire it up, however, it's obvious something is missing—a sense of pizzazz. For sure, the pixel pitch is nice and crisp, albeit not as sharp as a 32-inch 4K panel. For the most part, it's nicely calibrated out of the box, too. The black and white scales show loads of detail, and gradients are flawless. Additional points should also be awarded for a proper execution of FreeSync that isn't spoiled by nasty ghosting when enabled.

But there's no getting away from it. Compared to the likes of, say, the Asus PA329Q, and its quantum dot-enhanced colors, the 38UC99 looks dull. It even looks tepid next to some of the cheaper panels here. The outright contrast and black levels are underwhelming, and the anti-glare coating suffers from a little sparkle. All of which means it looks great on paper, and comes very nicely calibrated, but lacks the kind of visual fizz you've every right to expect at this price. It's a certainly good monitor, but it's definitely not a great one.

VERDICT 7

LG 38UC99

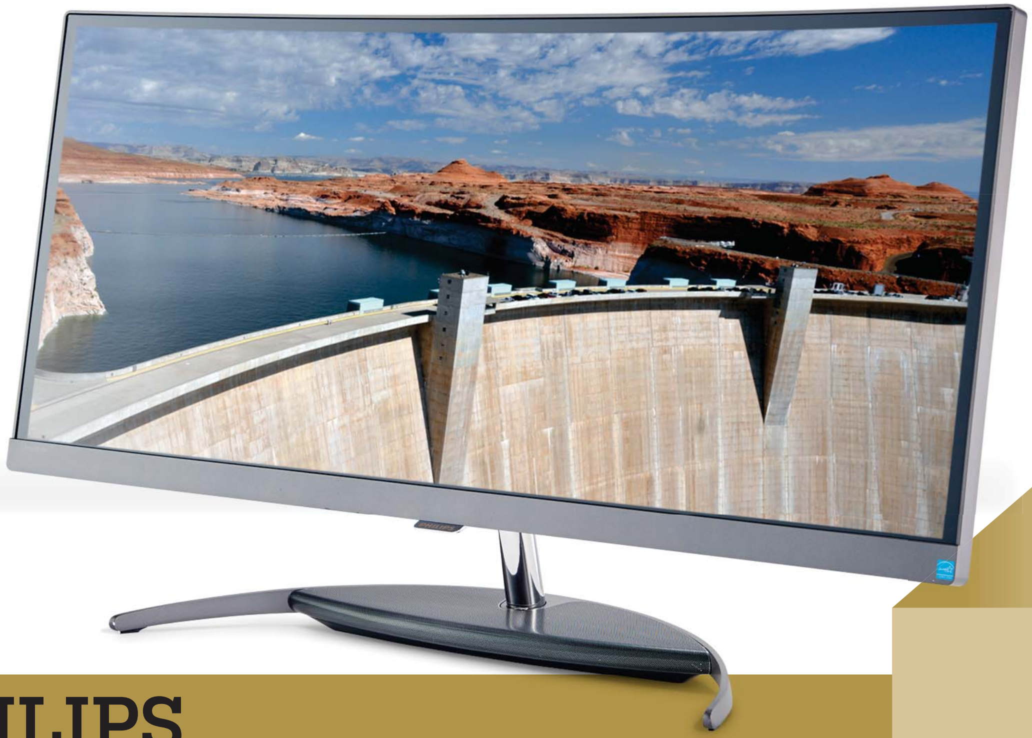
⊞ **OSCAR WINNER** Generous proportions; plenty of pixels; nicely calibrated; decent pixel pitch.

⊟ **RAZZIE NOMINEE** Dull image quality; very expensive; short on frills and cutting-edge features.

$1,499, www.lg.com

SPECIFICATIONS

Panel Size	37.5-inch
Native Resolution	3840x1600
Pixels Per Inch	111
Panel Type	IPS
Max Refresh	75Hz
Response	5ms
Display Inputs	1x HDMI, 1x DisplayPort
Connectivity	USB
VESA Mount	100 x 100mm
Warranty	One year



PHILIPS BRILLIANCE BDM3490UC

Ahead of the curve or overpriced?

FORGIVE US A PHILOSOPHICAL interlude. If you need to double-check both the product itself and its spec sheet to confirm the presence of a given technology or feature, does that feature have any value?

Adaptive frame sync had us pondering along those lines. It's one of those technologies where it isn't obvious whether it's working correctly. But we've never felt like that about curved LCD screens. They split opinion, sure, but not being able to see the difference hasn't been an issue.

Until the Philips Brilliance BDM3490UC, that is. That's surprising, because it has the same 3800R curvature as several other 34-inch displays. The explanation very likely comes down to context. Both of the Samsung displays in this group test are so curvy by comparison, the Philips looks flat. The mild curve makes for moderate impact at most. That either makes it a good choice if you're unsure of the merits of curved panels, or a monitor that doesn't fully deliver on the curved-screen proposition.

Curvature aside, however, how does the BDM3490UC shape up? On paper, it all looks pretty familiar. The 3440x1440 pixel grid is standard for a 21:9 and 34-inch screen, as is the IPS panel technology. Elsewhere, the feature set is pretty thin when it comes to image quality enhancements. There's no HDR, no quantum dots, no high refresh, no exotic color space support.

All that would be fine were it not for one other detail: It costs around $1,100. That's mega money given the overall spec, and means the Philips is not only nearly double the money of the similar AOC monitor, but more expensive than the 100Hz, ultra-curved, quantum dot Samsung CF791. Question is, can the Philips somehow make up for its implausibly high price?

In a word, no. Don't get us wrong, this is a very nice screen. It has the measure of LG's 38UC99 for colors, pop, and punch, for instance. There are no nasties from the factory calibration, either. The white and black scales look good, and the gradients are nice and smooth. Ditto the anti-glare coating. The pixel response is decent for an IPS display, and Philips includes an option in the OSD to tweak the overdrive levels, and thus choose between speed and accuracy.

The chassis has an intriguingly spacey design, and feels well put together, even if the tilt-only stand is pathetic at this price. All told, it's a nice display. Shave $400 or $500 off the price, and it would be easy to recommend. We wouldn't be surprised to see it experience a major price drop. Until that happens, it's impossible to recommend when there are better screens for less cash.

VERDICT

7

Philips Brilliance BDM3490UC

+ POLE POSITION Nice IPS panel; high-quality chassis; solid all-round image quality.

− ENGINE FAILURE Staggeringly expensive; limited feature set; panel curve is arguably too subtle.

$1,100, www.philips.com

SPECIFICATIONS

Panel Size	34-inch
Native Resolution	3440x1440
Pixels Per Inch	110
Panel Type	IPS
Max Refresh	60Hz
Response	5ms
Display Inputs	3x HDMI, 1x DisplayPort
Connectivity	USB, 3.5mm audio
VESA Mount	No
Warranty	Three years

SAMSUNG CF791

Samsung gets a serious curve on

IT'S REMARKABLE how quickly the 34-inch, 21:9 aspect segment has become almost a staple in the higher echelons of the PC monitor market. Even with the addition of a curved panel, you're still not talking about anything exotic. Just a few years ago, a 34-inch panel with such superwide proportions would have seemed almost preposterous.

Still, even by the standards of such screens, the Samsung CF791 is special. For starters, it boasts an LED backlight enhanced with quantum dot technology. The basics of quantum dot involve materials that absorb certain frequencies of light, convert them, and re-emit. The "quantum" bit is because the semiconductor crystal on which it's based leverages a nanoscale effect known as quantum confinement, which involves electron holes, two-dimensional potential wells, and the exciton Bohr radius. But you knew that, obviously.

Basically, it takes suboptimal light output from an LED backlight, and buffs it up to enable increased color vibrancy and fidelity. The CF791 also sports a couple of gaming-friendly features: 100Hz refresh and AMD FreeSync adaptive refresh support.

Finally, it's curved. Not just any old curved, but 1500R curved. That means the curve's radius is a yard and a half or so—over twice as curved as the Philips Brilliance. Whether that's a good thing or not is subjective. Let's just say if you're not sure about curves, steer clear of the CF791.

Curvature aside, this is a great-looking panel. It doesn't immediately blow your socks off like an HDR UHDTV playing high dynamic range content. But it's more vibrant than a non-quantum dot monitor.

The default calibration is a bit warm for our liking, pushing flesh tones toward pink. There's a big gap between the color temperature presets, too, so you need to do a full calibration to dial that out. But that's typical given the panel tech is VA, rather than IPS. Elsewhere, it's well set up out of the box, with a good balance between detail in whites and black, and smooth gradients.

Objective concerns aside, the subjective experience rendering 4K video is stunning, even if the 3440x1440 native resolution is sub-4K fidelity. With that 100Hz refresh and adaptive sync support, plus better pixel response than just about any VA panel we've seen, this is one heck of a gaming panel, too. And it's a good-looking hunk of consumer electronics, thanks to Samsung's typically snazzy styling. With that hefty curvature and the extreme 21:9 aspect, it's an acquired taste rather than a sure-fire hit, but if you're looking for a 34-inch curved screen, the CF791 should be near the top of your list.

VERDICT

8

Samsung CF791

➕ **BEAUTIFUL** Gorgeous colors; epic, cinematic LCD panel; nice gaming extras.

➖ **BENT** Extreme curve not to all tastes; ditto 21:9 aspect; pretty pricey for a 34-inch panel.

$999, www.samsung.com

SPECIFICATIONS

Panel Size	34-inch
Native Resolution	3440x1440
Pixels Per Inch	110
Panel Type	VA
Max Refresh	100Hz
Response	4ms
Display Inputs	2x HDMI, 1x DisplayPort
Connectivity	USB, 3.5mm audio
VESA Mount	No
Warranty	Three years

SAMSUNG UN55KS9500

If bigger is better, we've found a winner

WORD TO THE WISE: Unless you are seriously considering a large UHDTV like the Samsung 9 Series as some kind of PC monitor, don't try one just for fun. It will ruin you for conventional PC monitors. It makes almost every other monitor seem tiny.

Take the LG 38UC99. It's a 38-inch beast, with a 21:9 aspect ratio, and by any sane metric, it's a big PC monitor. But we set it up after assessing this Samsung monster, and it looked pitiful. At 55 inches, this Samsung 9 Series model is nothing special by UHDTV standards (they go up to 78 inches), but set up as a PC monitor at PC monitor viewing distances, it dominates your field of view, and recalibrates your definition of big.

However, don't go thinking this screen is a one-trick pony. This isn't like the bad old days of large HDTVs, where size was all you got, and everything else—color accuracy, response, pixel pitch—sucked. Thanks to that 4K 3840x2160 grid, the pixel pitch is reasonable, if not awe-inspiring. Just as impressive is the out-of-the box calibration and ease of use. Hooked up to a modern graphics card with HDMI 2.0 support, in this case an Nvidia GeForce GTX 1080, this thing just works. What's more, both black and white scales show plenty of detail, and gradient rendering is smooth. There's little, if any, noticeable input lag, either. In other words, it leaps all the hurdles that TVs used to stumble over when used as a PC monitor.

That's thanks in part to the fact that this 9 Series Samsung is a member of the brave new army of HDR TVs. With support for the HDR 1000 standard come several features that help it perform in the exacting environment of a PC, including expanded color space, with 10-bit per channel capability, and an LED backlight augmented by local dimming and quantum dot tech.

The result is stunning, but has its limitations. As a gaming monitor, it is staggering. The huge panel with plenty of curve makes for an incredibly immersive experience. It is the most impressive gaming display we've experienced, though the lack of both 120Hz-plus refresh support and adaptive frame synching means it can't check every gaming box.

It's stellar for 4K video content, too. But as a conventional PC monitor for web browsing or productivity work, it's less convincing. While the pixel pitch is tolerable, fonts aren't nearly as crisp as a 32-inch 4K monitor. And you don't actually get any additional screen real estate. The practicality of such a huge screen is questionable to say the least, too. And while the quantum dot-powered panel packs an incredible punch, it's hardly the last word in accuracy.

VERDICT 8

Samsung SUHD 9 Series

+ LIFE-ENHANCING Spectacular proportions; works surprisingly well as a monitor; latest HDR capabilities.

− MID-LIFE CRISIS Not exactly the last word in accuracy or practicality; fat pixel pitch even with 4K res.

$1,698, www.samsung.com

SPECIFICATIONS

Panel Size	55-inch
Native Resolution	3840x2160
Pixels Per Inch	80
Panel Type	VA
Max Refresh	60Hz
Response	Not quoted
Display Inputs	4x HDMI
Connectivity	3x USB, optical audio-out
VESA Mount	400 x 400mm
Warranty	One year

And the winner is...

ASUS PROART PA329Q

FIRST, A FEW WORDS ON HDR. It's undoubtedly the screen technology *du jour.* But it's also of marginal benefit on the PC—currently. The hardware is ready. You can buy an HDR screen, and the latest graphics cards from Nvidia and AMD are ready to roll. The problem is the content. There almost isn't any.

It's a particular problem on the PC at the moment. Service providers who are currently streaming in HDR, such as Amazon Prime, are yet to support the PC. Meanwhile, true HDR PC games—rather than games that render in HDR internally, but then knock the output back to SDR—have yet to arrive. With that in mind, we would recommend viewing HDR more as an investment in the future, rather than a killer feature today. The fact that few PC monitors are currently HDR-compliant is therefore no huge loss.

HDR or no, there are some fabulous screens on test this month. However, two stand out as relative stinkers, namely the Philips Brilliance BDM3490UC and the LG 38UC99. The Philips is undone purely by pricing. It's not a flawed product, it's just far too expensive. As for the LG, we had very high hopes. But its subdued, even dull, image quality pulls the rug out from under our enthusiasm. The remaining six screens have a huge amount to offer, though. The AOC U3477PQU is the easy pick as the value proposition. For around $600, you get a great 34-inch superwide IPS panel, wrapped in a slick chassis. Sure, it isn't exactly loaded with extras, but it's a large heap of screen for the money.

As for the Samsung 9 Series SUHDTV, in many ways, it's the most stunning display that we have ever hooked up to a PC. Thanks to its HDR-capable feature set, 4K resolution, and epic panel size, it makes for a simply stellar gaming experience, even without frame synching or high refresh support. It's not badly calibrated for use as a PC monitor, either. However, its size is also its downfall, both in terms of practicality, and the impact on pixel pitch. Epson's PowerLite 5040UB, meanwhile, falls into a category all of its own. As a vaguely affordable way to go beyond 1080p with a projector, we highly recommend it. But just like any projector, it has niche, albeit highly cinematic, appeal.

That just leaves us with our podium-position competitors, all three of which are superb displays. The Samsung CF791 is a fabulous multimedia display. Whether it's games, video, or productivity, it's a delight to use and genuinely innovative, with its quantum dot tech and extreme curve. The BenQ PD3200U, on the other hand, is the perfect foil for the CF791. It delivers precision and accuracy in a straightforward package, and at a competitive price.

But the overall honors have to go to the Asus ProArt PA329Q. It's a serious piece of precision display engineering. It has a strong feature set for professional content creation, gorgeous high-DPI 4K image quality, and plenty of future-proofing with the likes of quantum dot color enhancement. If you are serious about computing, it's one of the very best monitors money can buy.

> “The Asus ProArt PA329Q is a serious piece of precision display engineering, future-proofed with quantum dot color enhancement.

Windows 10

AMD

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SPEED UP WINDOWS 10

Give Windows a shot in the arm by cleaning up and optimizing your PC

By Nick Peers

Spring is in the air, so it's the perfect time to take a virtual vacuum to your computer. Every year, it's the same old story: Despite your best intentions, you rapidly lose control of what goes on to your PC, as programs are installed and forgotten, while gigabytes of files—from documents to photos and videos—are copied multiple times to a myriad locations, clogging up your hard drives. The result? A computer that's slow to start, performs sluggishly, and is approaching the limits of your storage capacity.

The changing of the seasons brings the whiff of new life, and again, you resolve to clean out your PC, and see whether you can bring it back to those heady days of its youth, when it performed with a noticeable zip. And this is where we come in. We're going to reveal all the tips and tools you need to get your PC properly cleaned up and raring to go. We'll avoid snake-oil remedies, such as Registry cleaning, to focus on techniques that actually make a difference to your PC's performance.

We've split the feature into four sections, enabling you to take your cleaning as far as you wish. Don't want to dig too deep? Our light clean focuses on quick and easy ways to clean out space using only those tools provided by Windows itself. Feeling a bit braver? We introduce a couple of tools that go further than Windows does. Then we move on to tackle the problem of duplicate files, helping you preserve just the essentials, and freeing up tens (or hundreds) of gigabytes in the process.

If you're still not satisfied, we push the boat out even further with our deep clean, revealing how to balance the competing demands of your PC's resources, strip back unnecessary services, and optimize older hard drives so they perform that bit quicker. The end result is a revitalized PC, one that more closely resembles the lean, mean speed machine you bought, ready and better able to face the challenges you'll throw at it over the next 12 months.

A LIGHT SPRING CLEAN

Discover how much space and resources you can reclaim armed with only Windows 10's tools

A light spring clean can free up drive space and improve your PC's performance without involving any hard work or even third-party tools. Everything we feature on these two pages is done using Windows' own built-in tools, so without further ado, let's get started.

First, check your hard drive is in good working order. The quickest way to force Windows 10 to perform a complete check on your hard drive is to right-click the "Start" button, and choose "Command Prompt (Admin)." Type the following into the command prompt window, then hit Enter:

```
$ chkdisk /f /r c:
```

You're told the drive can't be locked (because it's in use), so press Y, then when you next restart, Windows performs a complete check of your hard drive, attempting to correct any errors it comes across. If it finds and fixes any, you may immediately get a speed boost. Now repeat for any other drives you have attached—if you get a warning about forcing a dismount, we suggest hitting N, then Y to run the check when you next reboot. Once your drives have been checked, it's time to begin cleaning.

Remove Unwanted Apps

How many programs have you installed on your PC? How many do you still use? Now is the perfect time to go through all the desktop programs and Microsoft Store apps you have installed, cleaning out those you no longer need or use. To do this, click "Start → Settings." Select "System," followed by "Apps & features."

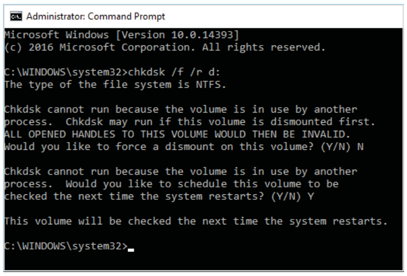
All installed apps and programs are listed alphabetically—you can, however, sort by size (useful if you need to free up drive space) or installation date. Go through the list, clicking any programs you no longer need, and choosing "Uninstall" to remove them using the standard program installer. Some uninstallers leave Registry entries and program files behind—for a more thorough way to remove programs, turn the page.

Perform a Disk Clean

Open File Explorer, and select "This PC" on the left to reveal a list of all your hard drives. Right-click your C drive (or the drive Windows is installed on), and choose "Properties," then click the '"Disk Clean-up" button. The step-by-step guide reveals how the tool works—basically, it enables you to quickly clear up all kinds of detritus, from the contents of various temporary folders to redundant system error logs, and even older System Restore points. You can run Disk Cleanup across other drives, too, but it's usually most effective on the drive Windows is installed on.

It's worth taking a pause before simply deleting everything that Windows suggests. For example, if you've just upgraded to a new version of Windows, you should find a "Previous Windows installation(s)" entry, offering tens of gigabytes of data ready to free up—don't select this until you're happy you won't be rolling back to that previous version (note that Windows usually deletes these files after a set time anyway; typically 30 days).

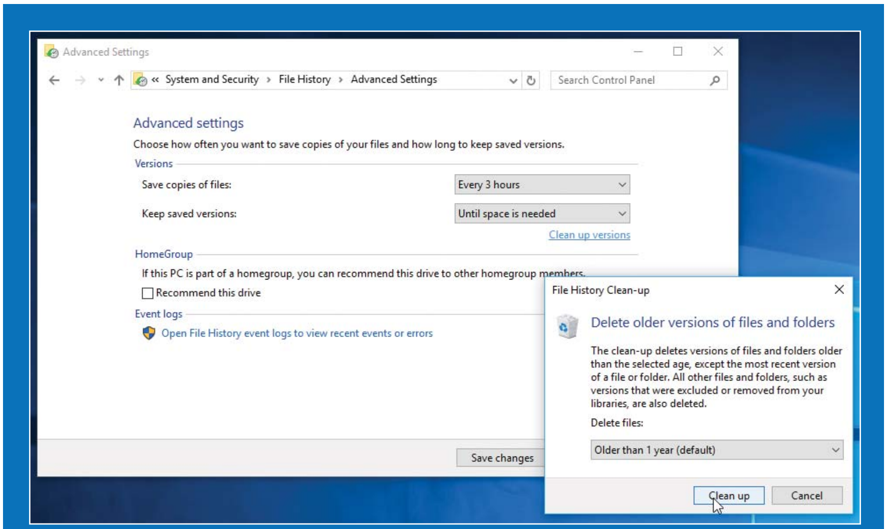
Recently installed a new driver and not sure whether it's causing problems? Don't



Administrator: Command Prompt

```
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\WINDOWS\system32>chkdsk /f /r d:
The type of the file system is NTFS.

Chkdsk cannot run because the volume is in use by another
process.  Chkdsk may run if this volume is dismounted first.
ALL OPENED HANDLES TO THIS VOLUME WOULD THEN BE INVALID.
Would you like to force a dismount on this volume? (Y/N) N

Chkdsk cannot run because the volume is in use by another
process.  Would you like to schedule this volume to be
checked the next time the system restarts? (Y/N) Y

This volume will be checked the next time the system restarts.

C:\WINDOWS\system32>_
```

Before embarking on your cleanup, make sure your drives are error-free.



Advanced settings

Choose how often you want to save copies of your files and how long to keep saved versions.

Versions

Save copies of files: Every 3 hours

Keep saved versions: Until space is needed

Clean up versions

HomeGroup

If this PC is part of a homegroup, you can recommend this drive to other homegroup members.

☐ Recommend this drive

Event logs

Open File History event logs to view recent events or errors

Delete older versions of files and folders

The clean-up deletes versions of files and folders older than the selected age, except the most recent version of a file or folder. All other files and folders, such as versions that were excluded or removed from your libraries, are also deleted.

Delete files: Older than 1 year (default)

Manage Backups

Hopefully, you're making good use of File History or Windows Backup to ensure your critical files are kept safe and sound. Both methods store multiple versions of your backups, giving you the option of rolling back the changes with individual files should you wish to restore an earlier version.

This protection comes with a price, however—increased consumption of drive space. If you're feeling the squeeze, reclaim some breathing room by removing the oldest backups. Right-click the "Start" button and choose "Control Panel." File History users should click "Save backup copies of your files with File History," then click "Advanced settings." You can change the frequency of backups (to reduce drive consumption going forward), plus set a time limit for how long backups are kept ("Until space is needed" is safest, but you can specify your own time). Click "Clean up versions" to clear out space by choosing what backups to delete (anything from all but the most recent to those backups older than two years).

If you use the Windows Backup tool, select "Back up and Restore (Windows 7)," and click "Manage space," then "View backups" to manually select which backups to remove. Remember that older backups may contain files you have subsequently deleted, so be sure you haven't mislaid any critical old files before cleaning up.

touch "Device driver packages," otherwise you lose the "Roll back" option in Device Manager. Finally, if you're in the middle of troubleshooting a problem using a tool such as WhoCrashed (www.resplendence.com), deleting the "System error memory dump files" is not recommended until you've finished fixing your problem. Long story short: Make sure you read the description of each setting before choosing whether or not to delete it, and if in doubt, leave it where it is for now.

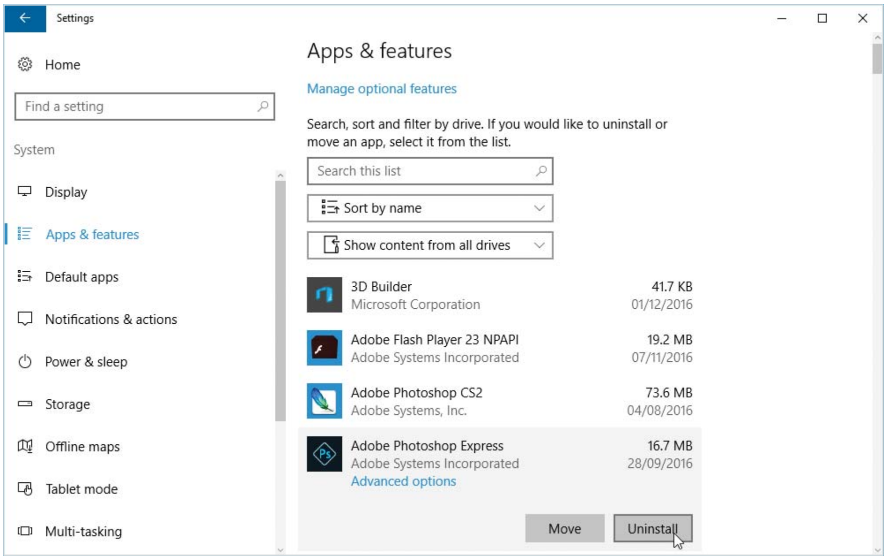
Trim Startup Items

One of the biggest bottlenecks of PC performance is the number of processes and programs running in the background. We look at more extreme ways of bringing these under control later on in the feature, but for now, the most effective way to give your PC a shot in the arm is to review—and clean out, if necessary—the programs that are set to start with your PC.

The simplest way to do this is with the help of Task Manager, so right-click the taskbar, and choose "Task Manager." Click "More details," if necessary, then switch to the "Startup" tab. You'll see a list of programs set to load with Windows, complete with publisher, status (enabled at this point), and—crucially—startup impact. This latter column helps you quickly determine which are the biggest resource-hogging programs.

Some programs are—by necessity—vital to the well-being of your PC, while others may be required on a regular basis, such as OneDrive or your cloud sync provider. Others, however, can be safely disabled, so they only run when you want them to. To do this, right-click the offending entry, and choose "Disable." It'll shave seconds off your startup, free up memory and other resources, and if you find enough items to disable, could make a noticeable difference to the performance of your PC.

Don't recognize an entry? Right-click it, and choose "Search online" to search the web for the underlying file name. Disabled entries can be restored later—right-click, choose "Enable"—but if you'd like to remove them completely, explore the program's own settings or preferences for an option to do so, and they should vanish from sight.



Apps & features

Manage optional features

Search, sort and filter by drive. If you would like to uninstall or move an app, select it from the list.

Search this list

Sort by name

Show content from all drives

3D Builder 41.7 KB
Microsoft Corporation 01/12/2016

Adobe Flash Player 23 NPAPI 19.2 MB
Adobe Systems Incorporated 07/11/2016

Adobe Photoshop CS2 73.6 MB
Adobe Systems, Inc. 04/08/2016

Adobe Photoshop Express 16.7 MB
Adobe Systems Incorporated 28/09/2016
Advanced options

Windows 10's uninstall tool covers both desktop programs and Microsoft Store apps.

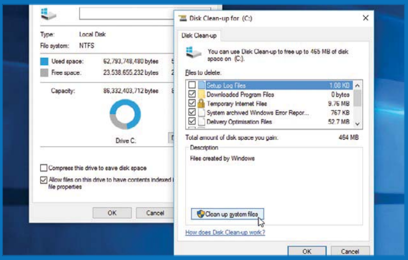
More Cleanup Tweaks

One way to improve performance is to take control of the Windows search index. This database helps speed up searches on frequently accessed folders, by scanning them for content, and storing them in a database. Sometimes, you'll want to add folders to this index—data folders stored outside your user folder, for instance—while removing others.

To manage these settings, type "indexing" into the "Search" box, and click "Change how Windows searches." Click "Modify" to choose which folders get indexed, by selecting or unselecting them, or click "Advanced," where you can change the index location (handy if you'd like to store it on another partition for retrieving after a Windows reinstall), or switch to the "File Types" tab to choose exactly which sort of files you want to include in your index. This latter tip enables you to tune the search index to only find specific document or image types, if those are the kinds of files you typically search for.

If you're left feeling dissatisfied by your light spring clean, turn the page to dig deeper and really start to clear the clutter.

FREE UP DRIVE SPACE WITH DISK CLEANUP



Type: Local Disk
File system: NTFS
Used space: 62,793,748,480 bytes
Free space: 23.538.655.232 bytes
Capacity: 86,332,403,712 bytes
Drive C:
☐ Compress this drive to save disk space
☑ Allow files on this drive to have contents indexed
file properties

You can use Disk Clean-up to free up to 465 MB of disk space on (C:).

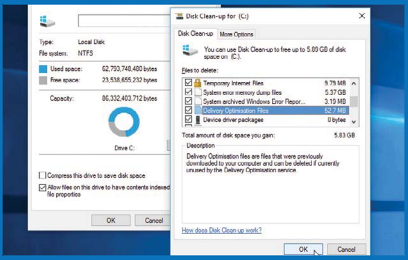
Files to delete:
☐ Setup Log Files 1.08 KB
☑ Downloaded Program Files 0 bytes
☑ Temporary Internet Files 9.76 MB
☑ System archived Windows Error Repor... 767 KB
☑ Delivery Optimisation Files 52.7 MB

Total amount of disk space you gain: 464 MB

Description
Files created by Windows

1. CHOOSE FULL SCAN

The first time you run Disk Cleanup, you're prompted to wait while it analyzes selected parts of your system. When the scan completes, you're shown an amount of disk space you can gain. For a more thorough scan, click the "Clean up system files" button, and wait while the scan repeats.



Type: Local Disk
File system: NTFS
Used space: 62,793,748,480 bytes
Free space: 23,538,655,232 bytes
Capacity: 86,332,403,712 bytes
Drive C:
☐ Compress this drive to save disk space
☑ Allow files on this drive to have contents indexed
file properties

You can use Disk Clean-up to free up to 5.89 GB of disk space on (C:).

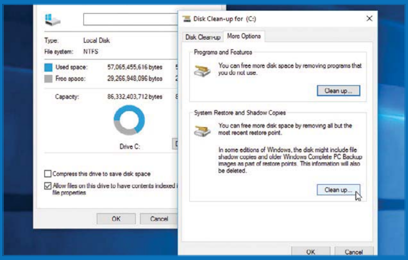
Files to delete:
☑ Temporary Internet Files 9.79 MB
☑ System error memory dump files 5.37 GB
☑ System archived Windows Error Repor... 3.19 MB
☑ Delivery Optimisation Files 52.7 MB
☑ Device driver packages 0 bytes

Total amount of disk space you gain: 5.83 GB

Description
Delivery Optimisation files are files that were previously downloaded to your computer and can be deleted if currently unused by the Delivery Optimisation service.

2. REVIEW SCAN ITEMS

You should find Windows has found lots more free space it can clear. Review each item by highlighting it for a description. You can select or unselect boxes to add or remove items to be cleaned—you should see the space gained figure adjust. Ready to clean? Click "OK → Delete Files."



Type: Local Disk
File system: NTFS
Used space: 57,065,455,616 bytes
Free space: 29,266,948,096 bytes
Capacity: 86,332,403,712 bytes
Drive C:
☐ Compress this drive to save disk space
☑ Allow files on this drive to have contents indexed
file properties

Programs and Features
You can free more disk space by removing programs that you do not use.

System Restore and Shadow Copies
You can free more disk space by removing all but the most recent restore point.

In some editions of Windows, the disk might include file shadow copies and older Windows Complete PC Backup images as part of restore points. This information will also be deleted.

3. MORE ITEMS TO CLEAN

If you have System Restore enabled, you can launch Disk Cleanup again and click "Clean up system files" for a second time. Switch to the "More Options" tab, and quickly wipe all but the most recent Restore points by clicking the relevant "Clean up" button after reading the warnings.

A MEDIUM SPRING CLEAN FOR YOUR PC

Need to free up more resources? With third-party tools, you can give Windows a more thorough clean

Dissatisfied with the results of spring cleaning with Windows' own tools? Time to go further. In this section, we'll perform a deeper clean on areas already covered, with the help of free third-party tools, which can also reach areas not touched by Windows. As always, caution should be your keyword. While cleaning out gigabytes of data is satisfying, it can lose its allure if you've been hasty and discover useful shortcuts, such as the Jump lists of programs, have been removed.

Remove Apps Thoroughly

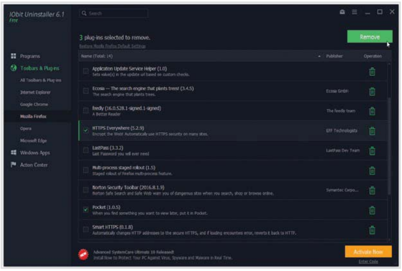
Standard program uninstallers tend to be conservative, leaving lots of detritus behind. This can soon mount up, and while you could employ the services of a Registry cleaner, the best time to clean up after a program is when you remove it.

Our tool of choice for cleaning out old programs is IObit Uninstaller (www.iobit.com/en/advanceduninstaller.php), which offers a "powerful scan" feature after a program's standard uninstaller finishes. This roots out leftover files and Registry entries, which you review manually, then decide whether or not to keep.

During installation, look out for prompts to install Advanced SystemCare Free—it's from IObit, so safe, but not needed for this feature. Once done, Uninstaller launches and you'll see a list of desktop programs. A number of options appear on the left, from "All Programs" to "Large Programs" and "Infrequently Used." The latter is good for weeding out programs you're not using.

You'll see a bin button appear on the right of each entry—click it, and the program in question is uninstalled. IObit Uninstaller offers to take a System Restore point before uninstalling, which we recommend for safety purposes. It then invokes the program's own uninstaller—ignore prompts to reboot now—and performs its own powerful scan. This roots out potential leftovers in the form of files and Registry entries—you review the list, decide what to remove, then reboot if necessary.

To remove programs in batches, select each program you want to get rid of, then click "Uninstall." The "Programs" list focuses on desktop programs only, so select "Windows Apps" to get a list of apps you've installed through the Microsoft Store, enabling you to remove those, too. Select "Toolbars & Plug-ins" to quickly review all the browser add-ons you have installed (all popular variants—IE, Chrome, Firefox, Opera, and Edge—are supported), plus remove those you don't want, need, or recognize. It's a quick and effective way to trim down your browser's resource usage.



3 plug-ins selected to remove.
Restore Mozilla Firefox Default Settings

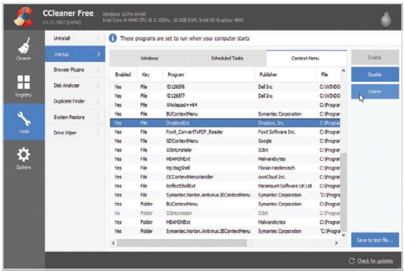
Name (Total: 14)	Publisher	Operation
☐ Application Update Service Helper (1.0) Sets value(s) in the update url based on custom checks.		
☐ Ecosia — The search engine that plants trees! (3.4.5) The search engine that plants trees.	Ecosia GmbH	
☐ feedly (16.0.528.1-signed.1-signed) A Better Reader	The feedly team	
☑ HTTPS Everywhere (5.2.9) Encrypt the Web! Automatically use HTTPS security on many sites.	EFF Technologists	
☐ LastPass (3.3.2) Last Password you will ever need	LastPass Dev Team	
☐ Multi-process staged rollout (1.5) Staged rollout of Firefox multi-process feature.		
☐ Norton Security Toolbar (2016.8.1.9) Norton Safe Search and Safe Web warn you of dangerous sites when you search, shop or browse online.	Symantec Corpo...	
☑ Pocket (1.0.5) When you find something you want to view later, put it in Pocket.		
☐ Smart HTTPS (0.1.8) Automatically changes HTTP addresses to the secure HTTPS, and if loading encounters error, reverts it back to HTTP.		

Advanced SystemCare Ultimate 10 Released!
Install Now to Protect Your PC Against Virus, Spyware and Malware in Real Time.

Remove unwanted browser add-ons to boost security, privacy, and performance.

Clean More Settings

One of the best free cleanup tools is CCleaner (www.piriform.com). The app boasts a number of tools to help you clean out the detritus and recover gigabytes of files. Its main cleaning component searches more than just basic Windows settings, including browser settings (a source of hundreds of megabytes of potential waste), plus popular programs, and apps. It's tempting to click "Analyze," then clean out everything it recommends, but you'll end up losing potentially useful settings. The step-by-step guide reveals how to use it to free up space without deleting those files you didn't know you needed.



Windows 10 Pro 64-bit
Intel Core i5-4440 CPU @ 3.10GHz, 16.0GB RAM, Intel HD Graphics 4600

These programs are set to run when your computer starts

Enabled	Key	Program	Publisher	File
Yes	File	!D1265f6	Dell Inc	C:\WINDO
Yes	File	!D1265f7	Dell Inc	C:\WINDO
Yes	File	ANotepad++64		C:\Prograr
Yes	File	BUContextMenu	Symantec Corporation	C:\Prograr
Yes	File	DropboxExt	Dropbox, Inc.	C:\Prograr
Yes	File	Foxit_ConvertToPDF_Reader	Foxit Software Inc.	C:\Prograr
Yes	File	GDContextMenu	Google	C:\Prograr
Yes	File	IObitUnstaler	IObit	C:\Prograr
Yes	File	MBAMShlExt	Malwarebytes	C:\Prograr
Yes	File	Mp3tagShell	Florian Heidenreich	C:\Prograr
Yes	File	OCContextMenuHandler	ownCloud Inc.	C:\Prograr
Yes	File	ReflectShellExt	Paramount Software UK Ltd	C:\Prograr
Yes	File	Symantec.Norton.Antivirus.IEContextMenu	Symantec Corporation	"C:\Progra
Yes	Folder	BUContextMenu	Symantec Corporation	C:\Prograr
No	Folder	IObitUnstaler	IObit	C:\Prograr
Yes	Folder	MBAMShlExt	Malwarebytes	C:\Prograr
Yes	Folder	Symantec.Norton.Antivirus.IEContextMenu	Symantec Corporation	"C:\Progra

Use CCleaner to strip back your context menus to make them more manageable.

Outside of its primary cleaning element, CCleaner offers a number of other tools. Its Registry cleaner is potentially the most dangerous, so skip that. Instead, select "Tools," where you'll find seven cleanup tools. The Uninstall section works in the same way as Windows' Apps & Features tool, but is outclassed by IObit Uninstaller.

Startup provides you with a more comprehensive list of programs and items that launch with Windows. This is split into three tabs. "Windows" contains a list of programs, organized by location (Registry or startup folder). It's the same list as in Task Manager, with one crucial difference: you can permanently delete entries (with care), as opposed to just disabling them.

Switch to "Scheduled Tasks" to review what tasks Windows and other programs have set up—you'll find items such as backup tasks, program update tasks, and so on here. Again, you can disable or delete items. Select "Advanced" mode, and various Windows-related tasks are shown. These should be left alone, so leave the box unselected after reviewing it.

One final tab—"Context Menu"—is worth exploring. Frustrated at how programs clutter up the menus that appear when you right-click items in File Explorer? You'll find these items here, referencing "Directory" (when you right-click a folder), "Drive," and "File" (when you right-click a specific file type—sadly, the actual file isn't listed). Disable or delete those you don't want—if they keep coming back, examine the program's settings to see if you can disable them from there, or use its intransigence as an excuse to remove the app completely.

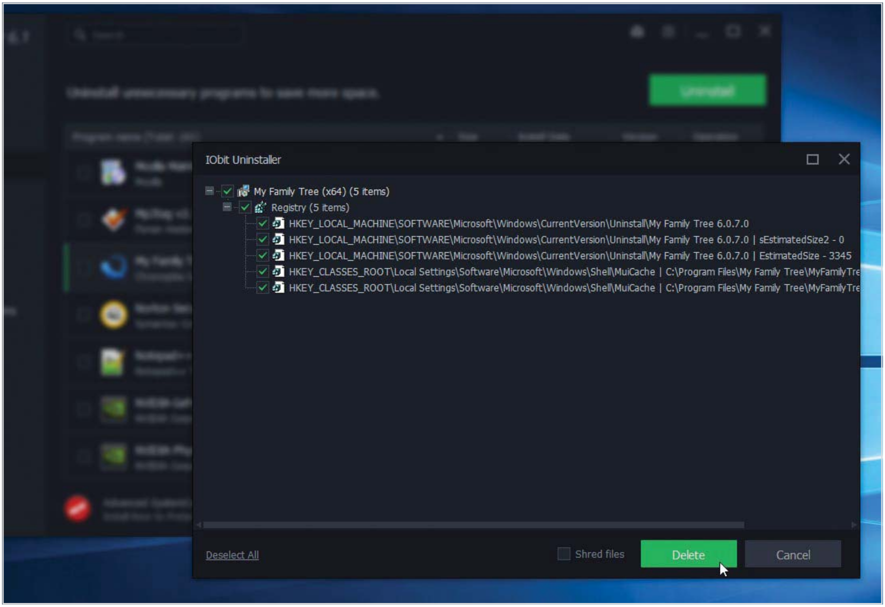
More Tweaks

The "Browser Plugins" tab works in a similar way to IObit Uninstaller's "Toolbars & Plugins" section—it's a matter of personal preference as to which one you use. Skip the Disk Analyzer and Duplicate Finder tools for now—we'll look at these (and more powerful alternatives) later on.

System Restore lets you view all the Restore points on your PC. Each one is clearly labeled, and you can remove them individually or in groups (hold Ctrl as you click each one to select it) without affecting others. The most recent Restore point is always grayed out for safety reasons.

The final tool, Driver Wiper, makes it possible to wipe free space or (with the usual precautions) an entire drive securely. Instead of marking deleted files as space available for writing over, making them vulnerable to data recovery tools, you can securely wipe the space by overwriting it.

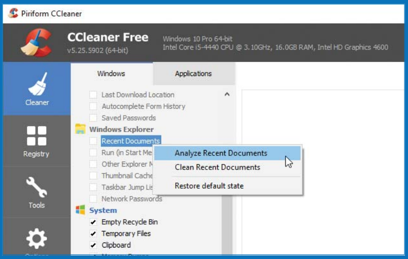
This is slow, and should only be done when you have sensitive data to wipe. You can also wipe free space and mark non-deleted files and folders for secure removal from CCleaner's main Cleaner component—scroll to the bottom of the "Windows" tab, and select each box ("Custom Files and Folders" refers to any files or folders you specify under "Options → Include"). If you'd like CCleaner to securely wipe all files from its Cleaner tool, go to "Options → Settings," and select "Secure file deletion (Slower)."


IObit Uninstaller
Deselect All
Shred files
Delete
Cancel

My Family Tree (x64) (5 items)
Registry (5 items)
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall\My Family Tree 6.0.7.0
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall\My Family Tree 6.0.7.0 | sEstimatedSize2 - 0
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall\My Family Tree 6.0.7.0 | EstimatedSize - 3345
HKEY_CLASSES_ROOT\Local Settings\Software\Microsoft\Windows\Shell\MuiCache | C:\Program Files\My Family Tree\MyFamilyTre
HKEY_CLASSES_ROOT\Local Settings\Software\Microsoft\Windows\Shell\MuiCache | C:\Program Files\My Family Tree\MyFamilyTre

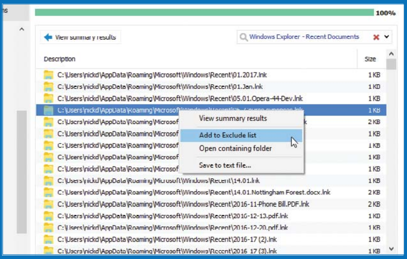
IObit Uninstaller provides you with a powerful tool for removing extra leftover elements.

CLEAN OUT YOUR SYSTEM WITH CCLEANER


Piriform CCleaner
CCleaner Free
v5.25.5902 (64-bit)
Windows 10 Pro 64-bit
Intel Core i5-4440 CPU @ 3.10GHz, 16.0GB RAM, Intel HD Graphics 4600
Cleaner
Registry
Tools
Windows
Applications
Last Download Location
Autocomplete Form History
Saved Passwords
Windows Explorer
Recent Documents
Run (in Start Menu)
Other Explorer MRUs
Thumbnail Cache
Taskbar Jump Lists
Network Passwords
System
Empty Recycle Bin
Temporary Files
Clipboard
Analyze Recent Documents
Clean Recent Documents
Restore default state

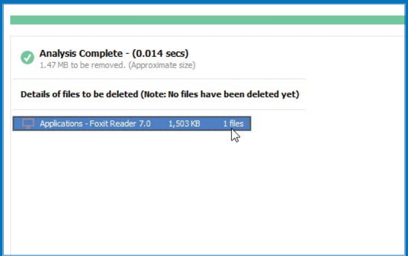
1. CHOOSE WHAT TO SCAN

CCleaner's Cleaner component comes with some settings pre-selected. It's a good idea to review these thoroughly, unselecting those you don't want to lose, and selecting the settings you'd like to clean. Unsure what files a particular setting might delete? Right-click it and choose "Analyze...."


100%
View summary results
Windows Explorer - Recent Documents
Description
Size
View summary results
Add to Exclude list
Open containing folder
Save to text file...

2. REVIEW ANALYSIS

CCleaner performs a limited scan on the chosen setting. To view exactly what it's found, double-click the summary in the right-hand pane (such as "Microsoft Edge—Download History"), and a list of all files is shown. Right-click to exclude them from future scans or open the parent folder.



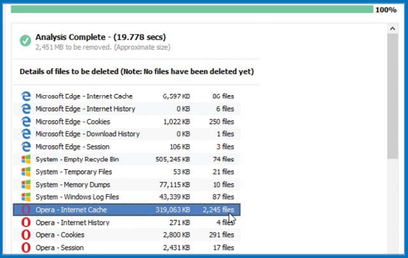
Analysis Complete - (0.014 secs)
1.47 MB to be removed. (Approximate size)

Details of files to be deleted (Note: No files have been deleted yet)

Applications - Foxit Reader 7.0 1,503 KB 1 files

3. CONTINUE CHECKING

Scroll down to view all Windows settings—if in doubt, perform an analysis on the specific setting, or unselect it to exclude it from the full scan. When done, switch to the "Applications" tab to see which programs are supported. Scan these in the same way, unselecting those you wish to leave alone.



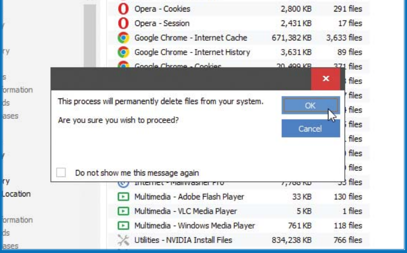
Analysis Complete - (19.778 secs)
2,451 MB to be removed. (Approximate size)

Details of files to be deleted (Note: No files have been deleted yet)

Microsoft Edge - Internet Cache	6,597 KB	86 files
Microsoft Edge - Internet History	0 KB	6 files
Microsoft Edge - Cookies	1,022 KB	250 files
Microsoft Edge - Download History	0 KB	1 files
Microsoft Edge - Session	106 KB	3 files
System - Empty Recycle Bin	505,245 KB	74 files
System - Temporary Files	53 KB	21 files
System - Memory Dumps	77,115 KB	10 files
System - Windows Log Files	43,339 KB	87 files
Opera - Internet Cache	319,063 KB	2,245 files
Opera - Internet History	271 KB	4 files
Opera - Cookies	2,800 KB	291 files
Opera - Session	2,431 KB	17 files

4. ANALYZE AND CLEAN

Once you're ready, click "Analyze" and wait while CCleaner performs a complete scan. When it's complete, a summary is shown, listing all the components you've selected, complete with how much space you might save. As before, review individual components by double-clicking them.



This process will permanently delete files from your system.

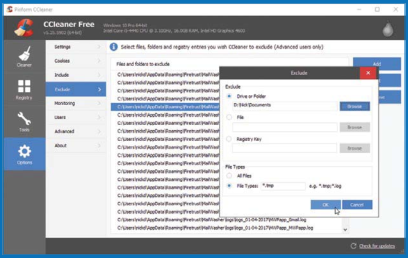
Are you sure you wish to proceed?

☐ Do not show me this message again

Opera - Cookies	2,800 KB	291 files
Opera - Session	2,431 KB	17 files
Google Chrome - Internet Cache	671,382 KB	3,633 files
Google Chrome - Internet History	3,631 KB	89 files
Multimedia - Adobe Flash Player	33 KB	130 files
Multimedia - VLC Media Player	5 KB	1 files
Multimedia - Windows Media Player	761 KB	118 files
Utilities - NVIDIA Install Files	834,238 KB	766 files

5. CLEAN UP YOUR PC

Ready? Click "Run Cleaner." A warning dialog pops up—this is your last chance to back out (files are deleted, not sent to the Recycle Bin). If you're happy to proceed, click "OK," and watch as CCleaner clears up gigabytes of hard drive space to give you some much-needed breathing space.


CCleaner Free
Cleaner
Registry
Tools
Options
Settings
Cookies
Include
Exclude
Monitoring
Users
Advanced
About
Exclude
Drive or Folder
File
Registry Key
File Types
OK
Cancel
Add
Browse
Check for updates

6. MANAGE EXCLUSIONS

Click "Options," and select "Exclude" to review what items are excluded from your scans. You can remove files you've placed here (Ctrl-click those files to select them, then click "Remove"), or add files, folders, Registry keys (not relevant here), and file types to the list by clicking "Add."

MAKE YOUR HARD DRIVE MORE MANAGEABLE

Discover how to bring order to your chaotic hard drive

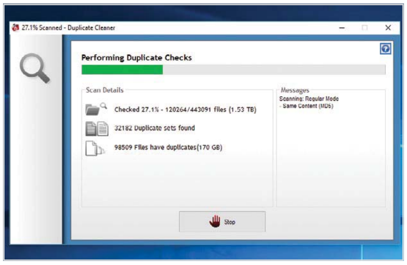
Your PC is hopefully noticeably zippier, but there's still room for improvement. Before we tackle a really deep spring clean, let's divert our attention for a moment to hard drive management. Unless you're the most organized person in the world, it's likely your filing system is a little haphazard. And if you've got multiple hard drives, it's likely you have multiple copies of files, too.

First, consult the box below for general advice on what to look for when rooting out and removing duplicates—this could save you from potentially deleting the wrong file or files when you come to clean up.

Find Duplicates Quickly

CCleaner comes with a built-in file duplicate finder, but it's not very sophisticated. It matches purely on file name, size, and date last modified. We want something more thorough, so download the free version of Duplicate Cleaner (www.digitalvolcano.co.uk/duplicatecleaner.html), which has all the functionality you need.

First, choose what to search for—the default options search files by content rather than name, size, or date. You can also set filters—such as documents, pictures, or music—or files to include or exclude, plus limit your search to files of a certain size and date. For a system-wide sweep, leave the defaults as they are, and switch to the ‘Scan Location” tab.


27.1% Scanned - Duplicate Cleaner
Performing Duplicate Checks
Scan Details
Messages
Stop

Checked 27.1% - 120264/443091 files (1.53 TB)

32182 Duplicate sets found

98509 Files have duplicates(170 GB)

Scanning: Regular Mode
- Same Content (MD5)

The scanning process can take some time—hours, in fact. Patience is a virtue.

Next, elect where to search using the tools provided—whether it's entire drives or specific folders. If you want to exclude a specific location, add it in the usual way, then right-click it, and choose "Exclude Selected Path(s)." When you're ready, click the "Scan Now" button, and wait while Duplicate Cleaner does its work—it's not a quick process, so be prepared to leave your PC on for several hours or even overnight, depending on the size of the folders you're scanning. If necessary, minimize the scan window while you work on other tasks.

You can review the results on the "Duplicate Files" tab ("Duplicate Folders" is restricted to Pro users only)—they're listed in no particular order. Focus on the largest files by clicking the "Size" column header twice. You can now go through the list, manually selecting the duplicates you wish to remove, or you can use the "Selection Assistant" buttons to speed things up.

If you have a single folder or location where your original files sit, you can specify that with "Select by Location," which tells Duplicate Cleaner to target files in other folders for deletion. Once done, you can select all other files by clicking the magic wand button, and choosing "Mark → Select by group → All but one file in each group."

Duplicate Cleaner offers many matching tools to try to automate the selection process, but you may find it's easier, quicker, and safer to go through the list by hand, weeding out unwanted files, and periodically clicking "File Removal." From here, you can choose whether to delete the file completely, or send it to the Recycle Bin.

The program can be quite slow at times, and appear non-responsive. The trick is to be patient, and it soon comes back to life. If there's a long list of files to clean, you may want to take a break. Simply close the program—when you next launch Duplicate Cleaner, your results are ready and waiting for you to continue processing.

Manage Your Photos

When it comes to managing your photos, you need a tool that can search for similar-looking images, as well as identical matches. You'll have to upgrade to the Pro version of Duplicate Cleaner for that functionality, so our favorite alternative is the free—and open-source—AntiDupl (http://antidupl.sourceforge.net/english/index.html). Download the latest version, and double-click the .exe file to extract the program folder. Open this, and double-click "AntiDupl.NET.exe" to get started. The step-by-step guide reveals the basic procedure you need to follow, but as always, it pays to

What to Look for When Cleaning Duplicates

Backups of critical files are—of course—important, so any file cleaning needs to bear this in mind. Also, you may have renamed a file without changing its content, so a good duplicate finder utility should not simply match files by their names (which could be disastrous if two completely separate files with the same name become linked together), but also by the file's properties, too, from its size to the date it was last modified—that's especially important with digital photos that have been downloaded from different cloud providers, each one naming them differently. And what about the legions of digital photos cluttering up space on your hard drive? It's not uncommon to take five or more shots to ensure you get one usable one, but what about the rest? You only want to keep the best copy, but manually trawling through all your photographs can be a daunting task. Panic not—we'll reveal a tool that makes this job that bit simpler.

The end result should be this: You have one master copy of your files, plus as many backups as you need. These could be stored as an exact backup copy in one backup folder (which you'll need to identify to make sure it's ignored by the duplicate file finder), or you might have them backed up using a tool such as Windows' own File History, in which case, the backup won't be touched by your file weeding. All other copies—or slight variations—then become candidates for removal.

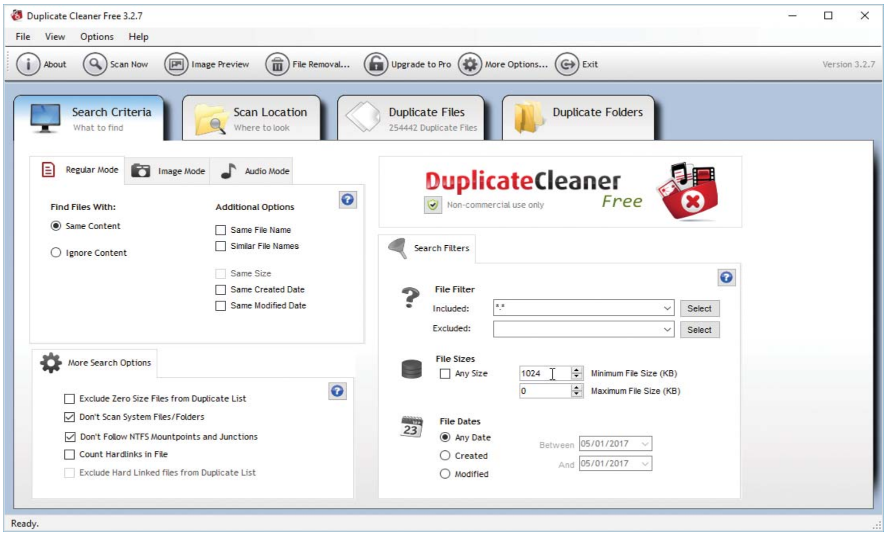
move slowly through each photo in the list, to be sure you've got the right match.

By default, AntiDupl assumes the first folder you added to it is the "master" folder—the one where the files are (by default) left untouched. When the search results appear, you'll see a preview of each photo on the left, complete with basic information confirming the match. Next to each photo, you'll see three buttons: taking the first photo, the top-most button deletes both copies, while the second icon overwrites the second copy with the first. The next button removes the top photo.

Below the two arrow buttons, you'll see three similar buttons, with the first one highlighted in red, indicating that the second photo is set to be deleted by default. Below this is a button allowing the second copy to overwrite the top one, and the final button—the hand signal—allows you to mark this match as a "mistake," ensuring it's ignored in future.

Click a button, and the desired action is performed now, and the next item is selected, ready for you to act on. You'll see similar buttons appear under the menu bar—if you select multiple entries together using Ctrl-click, you can click these buttons to perform the same action on all the matches. There's also a "Process selected results automatically" button for applying the default action to all of the results—not something we recommend, unless you're feeling very brave or working on a small set of results.

As you go down the list, you'll come to photos that aren't exact matches, allowing you to remove similar photos, too. All deleted photos are sent to the Recycle Bin by default, giving you a fail-safe in case you make a mistake, so be sure to empty the Bin once you're happy to free up the space.


Duplicate Cleaner Free 3.2.7
File View Options Help
About Scan Now Image Preview File Removal... Upgrade to Pro More Options... Exit
Version 3.2.7
Search Criteria
What to find
Scan Location
Where to look
Duplicate Files
254442 Duplicate Files
Duplicate Folders
Regular Mode Image Mode Audio Mode
DuplicateCleaner Free
Non-commercial use only
Search Filters
More Search Options

Find Files With:
● Same Content
○ Ignore Content

Additional Options
☐ Same File Name
☐ Similar File Names
☐ Same Size
☐ Same Created Date
☐ Same Modified Date

File Filter
Included: *.*
Excluded:

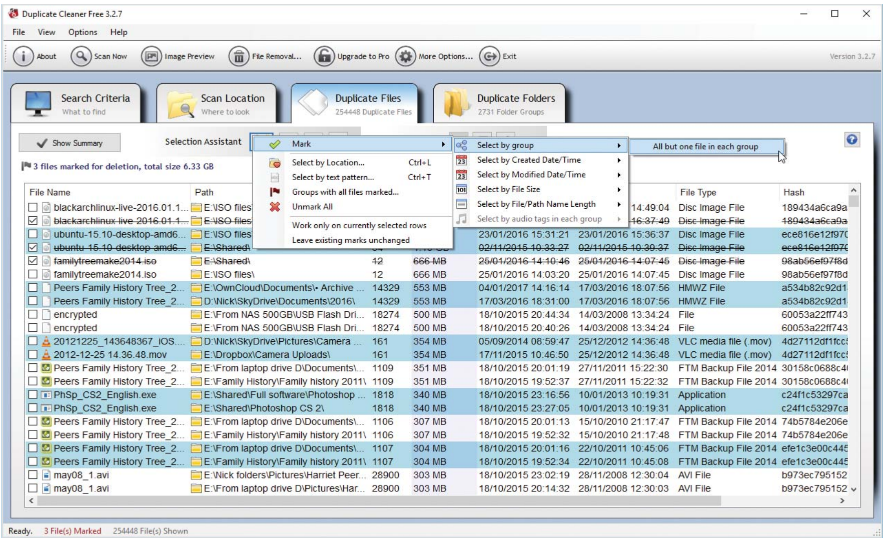
File Sizes
☐ Any Size
1024 Minimum File Size (KB)
0 Maximum File Size (KB)

File Dates
● Any Date
○ Created
○ Modified
Between 05/01/2017
And 05/01/2017

☐ Exclude Zero Size Files from Duplicate List
☑ Don't Scan System Files/Folders
☑ Don't Follow NTFS Mountpoints and Junctions
☐ Count Hardlinks in File
☐ Exclude Hard Linked files from Duplicate List

Ready.

You can configure Duplicate Cleaner to refine its search for specific content only.


Duplicate Cleaner Free 3.2.7
File View Options Help
About Scan Now Image Preview File Removal... Upgrade to Pro More Options... Exit
Version 3.2.7
Search Criteria
What to find
Scan Location
Where to look
Duplicate Files
254448 Duplicate Files
Duplicate Folders
2731 Folder Groups
Show Summary
Selection Assistant
Mark
Select by Location... Ctrl+L
Select by text pattern... Ctrl+T
Groups with all files marked...
Unmark All
Work only on currently selected rows
Leave existing marks unchanged
Select by group
Select by Created Date/Time
Select by Modified Date/Time
Select by File Size
Select by File/Path Name Length
Select by audio tags in each group
All but one file in each group

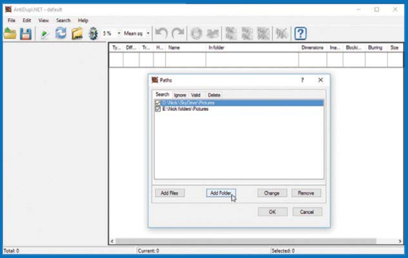
3 files marked for deletion, total size 6.33 GB

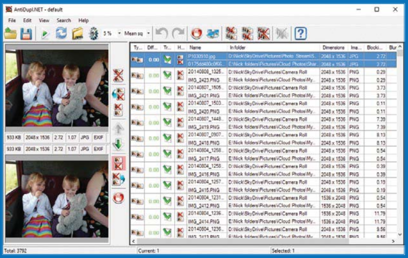
	File Name	Path					File Type	Hash
☐	blackarchlinux-live-2016.01.1...	E:\ISO files				14:49:04	Disc Image File	189434a6ca9a
☑	~~blackarchlinux-live-2016.01.1...~~	~~E:\ISO files~~				~~16:37:49~~	~~Disc Image File~~	~~189434a6ca9a~~
☐	ubuntu-15.10-desktop-amd6...	E:\ISO files			23/01/2016 15:31:21	23/01/2016 15:36:37	Disc Image File	ece816e12f970
☑	~~ubuntu-15.10-desktop-amd6...~~	~~E:\Shared\~~			~~02/11/2015 10:33:27~~	~~02/11/2015 10:39:37~~	~~Disc Image File~~	~~ece816e12f970~~
☑	~~familytreemake2014.iso~~	~~E:\Shared\~~	~~12~~	~~666 MB~~	~~25/01/2016 14:10:46~~	~~25/01/2016 14:07:45~~	~~Disc Image File~~	~~98ab56ef97f8d~~
☐	familytreemake2014.iso	E:\ISO files\	12	666 MB	25/01/2016 14:03:20	25/01/2016 14:07:45	Disc Image File	98ab56ef97f8d
☐	Peers Family History Tree_2...	E:\OwnCloud\Documents\• Archive ...	14329	553 MB	04/01/2017 14:16:14	17/03/2016 18:07:56	HMWZ File	a534b82c92d1
☐	Peers Family History Tree_2...	D:\Nick\SkyDrive\Documents\2016\	14329	553 MB	17/03/2016 18:31:00	17/03/2016 18:07:56	HMWZ File	a534b82c92d1
☐	encrypted	E:\From NAS 500GB\USB Flash Dri...	18274	500 MB	18/10/2015 20:44:34	14/03/2008 13:34:24	File	60053a22ff743
☐	encrypted	E:\From NAS 500GB\USB Flash Dri...	18274	500 MB	18/10/2015 20:40:26	14/03/2008 13:34:24	File	60053a22ff743
☐	20121225_143648367_iOS....	D:\Nick\SkyDrive\Pictures\Camera ...	161	354 MB	05/09/2014 08:59:47	25/12/2012 14:36:48	VLC media file (.mov)	4d27112df1fcc
☐	2012-12-25 14.36.48.mov	E:\Dropbox\Camera Uploads\	161	354 MB	17/11/2015 10:46:50	25/12/2012 14:36:48	VLC media file (.mov)	4d27112df1fcc
☐	Peers Family History Tree_2...	E:\From laptop drive D\Documents\...	1109	351 MB	18/10/2015 20:01:19	27/11/2011 15:22:30	FTM Backup File 2014	30158c0688c4
☐	Peers Family History Tree_2...	E:\Family History\Family history 2011\	1109	351 MB	18/10/2015 19:52:37	27/11/2011 15:22:32	FTM Backup File 2014	30158c0688c4
☐	PhSp_CS2_English.exe	E:\Shared\Full software\Photoshop ...	1818	340 MB	18/10/2015 23:16:56	10/01/2013 10:19:31	Application	c24f1c53297ca
☐	PhSp_CS2_English.exe	E:\Shared\Photoshop CS 2\	1818	340 MB	18/10/2015 23:27:05	10/01/2013 10:19:31	Application	c24f1c53297ca
☐	Peers Family History Tree_2...	E:\From laptop drive D\Documents\...	1106	307 MB	18/10/2015 20:01:13	15/10/2010 21:17:47	FTM Backup File 2014	74b5784e206e
☐	Peers Family History Tree_2...	E:\Family History\Family history 2011\	1106	307 MB	18/10/2015 19:52:32	15/10/2010 21:17:48	FTM Backup File 2014	74b5784e206e
☐	Peers Family History Tree_2...	E:\From laptop drive D\Documents\...	1107	304 MB	18/10/2015 20:01:16	22/10/2011 10:45:06	FTM Backup File 2014	efe1c3e00c445
☐	Peers Family History Tree_2...	E:\Family History\Family history 2011\	1107	304 MB	18/10/2015 19:52:34	22/10/2011 10:45:08	FTM Backup File 2014	efe1c3e00c445
☐	may08_1.avi	E:\Nick folders\Pictures\Harriet Peer...	28900	303 MB	18/10/2015 23:02:19	28/11/2008 12:30:04	AVI File	b973ec795152
☐	may08_1.avi	E:\From laptop drive D\Pictures\Har...	28900	303 MB	18/10/2015 20:14:32	28/11/2008 12:30:03	AVI File	b973ec795152

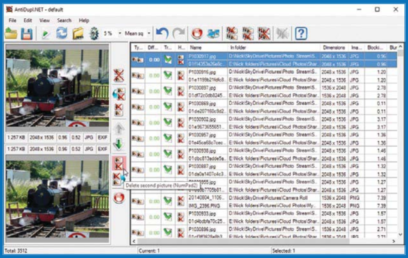
Ready. 3 File(s) Marked 254448 File(s) Shown

Speed up selection by having Duplicate Cleaner select all but one file in each lot of duplicates.

STREAMLINE YOUR PHOTO COLLECTION







1. SET SEARCH PARAMETERS
Launch AntiDupl, select "Search → Options," and select "Search rotated and mirror image dupls" if you wish (click "OK"). Now select "Search → Paths." Click "Add Folder" to add a folder or drive to search—repeat for as many locations as you need. Click "OK."

2. REVIEW RESULTS
Click the play button and wait while folders are searched and compared (click "Background Mode" to minimize to the System Tray). When the scan finishes, AntiDupl lists all found duplicates and similar files. See the main text for advice on what settings to choose for each find.

3. PERFORM CLEANUP
As you click a button for each result, it disappears from the list, and the next item comes into view. Work through the list—you can select multiple items at once using Ctrl-click. If you close the program, you can relaunch it later, and the results are saved, ready for you to resume working.

PERFORM A HEAVY-DUTY SPRING CLEAN

Still not satisfied with your cleaning efforts? Read on for a collection of more advanced cleaning tips

At last, we reach the final curtain. If your PC still isn't running as smoothly as you'd like, let us take more drastic steps to bring it under control in this last section on cleaning, diving deep to squeeze out every last possible optimization we can find. We'll also reveal some final tips for optimizing drive space, to ensure your hard drive doesn't fill up too quickly going forward.

First, you'll notice that we haven't included Registry cleaning as part of this feature. Registry cleaners would like you to think they can perform minor miracles when it comes to performance. They can't. Even if they weren't justifiably shunned for their ability to delete critical Registry entries along with genuinely redundant ones, the act of simply deleting Registry entries isn't enough in itself to speed things up. The fact is, Windows 10 is more than capable of managing and optimizing the Registry, so leave it well alone.

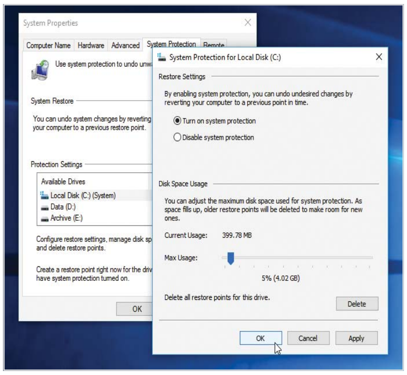
Defrag Your Drive

These days, more and more people have SSD drives, which don't require defragging. Older platter-based (HDD) drives do, however, and it's likely that you have at least one of these installed, either internally or attached via USB. Windows' built-in defrag tool should be adequate for most people's needs, but if you want to push the boat out further, download and install the free version of Defraggler (www.piriform.com/defraggler).

Defraggler can differentiate between SSD and HDD drives, so it only defrags the latter. Go to "Settings Options → Defrag tab," and you can optimize your drive by moving larger files to the end of the drive, which can help boost performance that bit more. It's also possible to analyze and defrag individual files via the "File list" tab, or by right-clicking the file in File Explorer—handy for a quick boost when working with specific large files.

Manage Services

Startup programs aren't the only things launching with Windows, extending your boot time, and grabbing resources—system (and third-party) services do, too. You can manually review and optimize these via the Services management console (type "services" into the "Search" box), but for a quick and easy optimization, download the free version of PC Services Optimizer (www.smartpcutilities.com/servicesoptimizer.html). Once installed, launch the app. After visiting Services Manager, waiting while the services list is populated, and clicking "Backup," select "Automatic Tuneup," and answer a series of questions split into four sections: "Hardware," "Security," "Internet & Network," and "System Functions." Click "OK," and any unnecessary services are promptly disabled, providing you with a minor speed boost.



Use system protection to undo unwa

You can undo system changes by reverting your computer to a previous restore point.

Configure restore settings, manage disk sp and delete restore points.

Create a restore point right now for the driv have system protection turned on.

By enabling system protection, you can undo undesired changes by reverting your computer to a previous point in time.

● Turn on system protection

○ Disable system protection

You can adjust the maximum disk space used for system protection. As space fills up, older restore points will be deleted to make room for new ones.

Current Usage: 399.78 MB

Max Usage: 5% (4.02 GB)

Delete all restore points for this drive.

Tweak System Restore so it doesn't take up too much space on your hard drive.

Gamers should also check out Gaming Mode. This enables you to temporarily disable services by switching Gaming Mode on to maximize performance for gaming or similar processor-intensive tasks, such as HD video editing. Click "Preset," and experiment with "Minimum," "Normal," or "Maximum" settings, or manually select which settings to apply. Don't be surprised if Windows changes appearance—when you switch off Gaming Mode, things should return to normal.

If things appear to go wrong after you've made your tweaks, simply click the "Rescue Center" button, and select your backup to undo your changes.

Visualize Drive Space

Running out of drive space, but unsure what's gobbling it all up? CCleaner offers a Disk Analyzer under "Tools" that can provide you with a quick summary for individual or collected drives, split into various categories (such as pictures, documents, or everything). When the scan completes, a pie chart divides everything

Switch to Portable Apps

Why let programs take more resources than they need? Instead of installing a program on your PC—letting it scatter itself all over your hard drive, and take up valuable space in the Registry—look to see if a portable alternative is available. Portable apps are programs that restrict themselves to a single folder; everything they need to run can be found inside that folder, so not only do you keep them in check (delete the folder, remove the program—completely), you also get to choose where they reside.

Portable apps are a particularly good choice when you have Windows installed on a small system drive—such as a 64GB or even 32GB SSD. You can store the apps on another drive, and leave enough space for Windows to run smoothly. Not only that, but if you have to reinstall Windows from scratch, the portable apps (and your settings) survive intact. You can even store portable apps on a USB thumb drive, enabling you to port them—and your preferences—to another computer.

A great place to start when building a portable app collection is www.portableapps.com. Install the PortableApps Platform tool, which provides a custom Start menu for easy access to your portable apps, plus makes it easy to install and update apps from its own extensive collection. You can add other portable apps—including those portable tools we've covered in this feature—by extracting them into folders inside the main PortableApps folder, and choosing "Apps → Refresh App Icons."

up, while the largest files are listed below, complete with a checkbox enabling you to select specific files to delete via the right-click menu.

An alternative tool to try is SpaceSniffer (www.uderzo.it/main_products/space_sniffer). This portable tool (be sure to right-click it, and choose "Run as administrator" to access all files on the selected drive) provides a visual view based on folder, rather than type, giving you insights into where all the space has gone, rather than what type of content is gobbling it up. Click a folder to peer inside it, or double-click to go inside, and drill down deeper until you locate what's taking all your space.

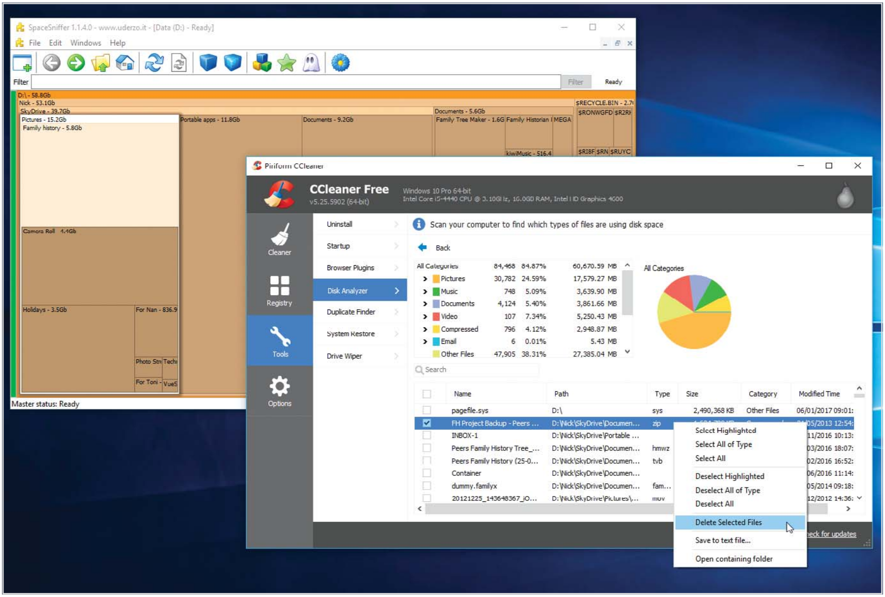
More Cleaning Tips

Type "restore point" into the "Search" box, and click "Create a restore point." Verify System Restore is switched on—if not, select your system drive, and click "Configure" to do so. When you come to allocate space, consider limiting it to 5GB or 5 percent, whichever is smallest. This provides a good balance between giving you usable Restore points and not swallowing up too much drive space.

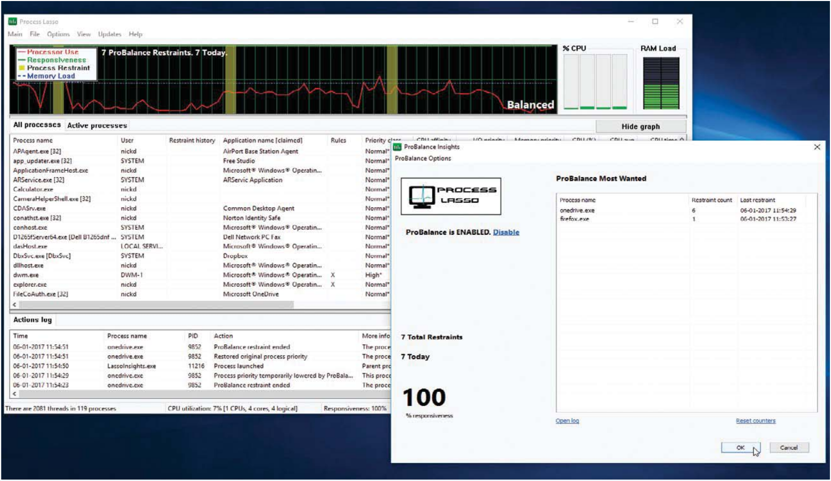
One obvious way to free up space without deleting any files is to compress them. The obvious solution would be to right-click the file (or folder), and choose "Send to → Compressed (zip) folder," but while you can easily browse their contents in File Explorer, third-party apps can't access the content unless you unzip it. An alternative is to use NTFS Compression instead, which compresses a selected folder while retaining its content. The folder is a little slower to process, but is more convenient to use. To do this, right-click the folder, and choose "Properties." Click "Advanced" under "General," and select "Compress contents to save disk space." Remember, it only works on NTFS-formatted hard drives.

One handy time-saving function is Jump Lists, which appear when you click ">" next to an application in the Start menu, or right-click its taskbar entry. It pays to take the time to manage these thoroughly—click the pin icon next to an entry to pin it permanently to the top of the list, or right-click a redundant entry and choose "Remove from this list" to get rid of it. You can quickly clear all Jump List entries using CCleaner (look in the "Windows Explorer" section of the cleaner).

Finally, if you want to take full control of the startup procedure, download and run Autoruns (https://bit.ly/autoruns). Switch to the "Logon" tab, and you'll find significantly more startup entries than those provided by Task Manager or CCleaner. Unselect an entry to disable it, or right-click it for more options, including deleting it and checking it for possible malware. ⏻


SpaceSniffer
CCleaner Free
Cleaner
Registry
Tools
Options
Uninstall
Startup
Browser Plugins
Disk Analyzer
Duplicate Finder
System Restore
Drive Wiper
Select Highlighted
Select All of Type
Select All
Deselect Highlighted
Deselect All of Type
Deselect All
Delete Selected Files
Save to text file...
Open containing folder

CCleaner and SpaceSniffer enable you to visualize your hard drive usage in different ways.


Process Lasso
7 ProBalance Restraints. 7 Today.
Balanced
% CPU
RAM Load
All processes
Active processes
Hide graph
Actions log
ProBalance Insights
PROCESS LASSO
ProBalance is ENABLED. Disable
ProBalance Most Wanted
7 Total Restraints
7 Today
100
OK
Cancel

Rein in Unruly Programs

The act of running multiple programs (never mind numerous background processes) is a delicate one, requiring a fine balance to keep everything running smoothly. It doesn't always work, which is why your PC may sometimes seemingly grind to a halt or act sluggishly for a few minutes.

If you're running Windows 10 on an older PC or low-powered tablet or laptop device, you may find it frequently sticks, due to the competing demands of different processes. One solution is to scale back what you do—keep open programs to a minimum, and trim startup back, too.

If this doesn't help, then downloading and installing the Free version of Process Lasso (https://bitsum.com/processlasso) will, and it can even help on more powerful setups as well. When prompted, leave the default options as they are, and the main window opens to show you what's running on your device, and how Process Lasso is balancing it. Its ProBalanced tool is up and running from the start, ensuring no process can overwhelm the system with its demands. A summary tells you how it's working, and the log reveals which processes have been neutered when their demands get too high (click "Insights" for a handy summary).

You can also tweak things further: Open the "Main" menu, and choose "SmartTrim" to free up physical RAM when it's safe to do so. Select "IdleSaver" if you'd like to cut energy usage, and choose "Gaming mode" for those times when you want to play games or perform other CPU-intensive tasks, such as ripping or encoding HD video.

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RECOVER YOUR DATA

Nothing is lost until you've looked for it,

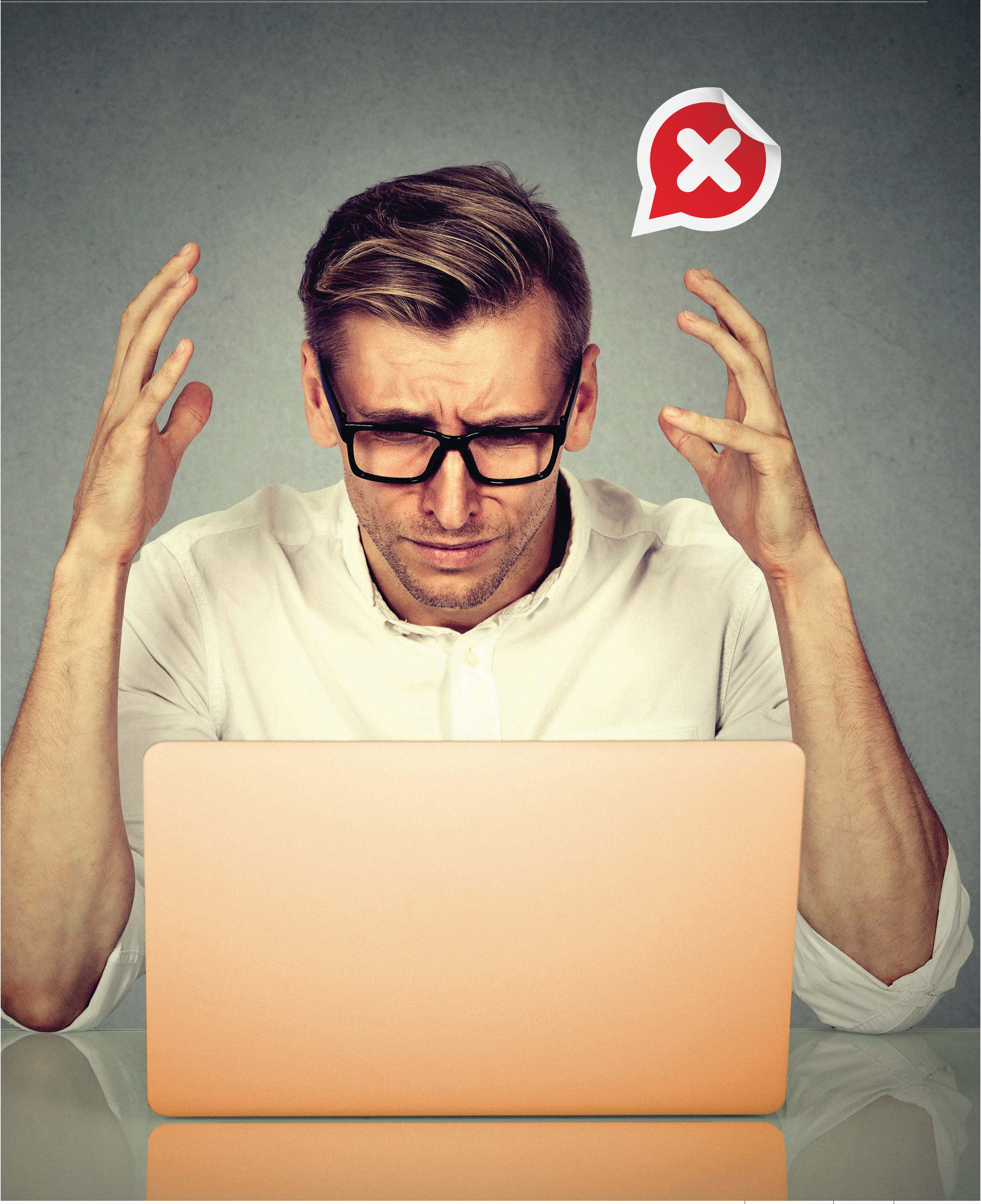
says Alex Cox

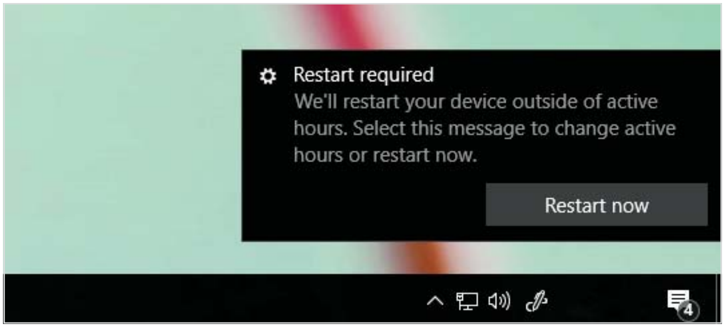
IMAGINE WITH US: The worst has happened. Everything you held dear is gone. You ignored the clicking of the hard drive, those error messages, that suspicious-looking file for too long. You clicked the thing you shouldn't have clicked. You emptied the Recycle Bin out of habit after letting your kids near your PC. And now? Now your photos are gone, your documents are dust, those precious family videos cast to the wind. Windows has gasped its last breath. All is lost.

Except that isn't necessarily the case. Data has a habit of hanging around. And if you're very lucky, and very careful, you could—in this hypothetical scenario —get all, or the vast majority, of your data back. Note that we're not going to be able to help you a huge amount in the case of massive hardware failure or physical damage, so if you've inadvertently sent 120V to that SSD, or unwisely dunked your laptop in the bath, you're either going to be on the hook for specialist clean room data recovery—which could set you back thousands of dollars, if it works at all—or completely out of luck.

If you're not just imagining things, and everything does appear to have gone, stop using your PC immediately, and read on. And if everything seems fine, read on anyway. You might learn a few things that'll save your bacon one day, and we'll help you get your hands on some tools that every home computer pro should have waiting in their back pocket for the worst of times.

And don't worry—we've not discounted the possibility that Windows has simply collapsed under its own weight, rendering your precious data comfortably stored, but otherwise inaccessible. By accessing your drive from another operating system entirely, you'll be able to get all that stuff back, too. And hey, if you fancy doing a bit of digital forensics, but your drives are currently in a good state, why not delete a few old files from a USB stick and follow along?





Restart required

We'll restart your device outside of active hours. Select this message to change active hours or restart now.

Don't let Windows update if you're missing crucial files.

BEFORE WE CAN EVEN THINK about doing any kind of data recovery, it's worth knowing how data is stored on the typical drive. Every situation is slightly different, of course, and we're taking an incredibly basic look at NTFS formatting here; other filesystems work in different ways, although with the right software, you should be able to affect a recovery from just about anything.

The typical drive is broken into partitions. These aren't physical breaks, they're logical—a certain portion of the drive's bits are allocated, in a contiguous manner, to split the drive apart into individually managed sections, known as volumes. Information about these volumes—their size, location on the drive, and the like—is stored in the drive's Partition Table, which sits alongside the Master Boot Record (MBR) in the first sectors of the drive. The MBR is accessed when you boot your PC, so the BIOS knows where it's heading.

Each volume is invisibly broken into more sections. The Master File Table (MFT) is the most important of these. It's a database that contains information about every file and folder on your drive, pointers to them, and, in some cases, even entire files, if they're smaller than about 512 bytes. Before the MFT is a boot sector, which holds a bit more specific information about the volume—most importantly, it points to where the MFT is located—and, if the partition is both active and designated as a primary partition, loads NTldr to kick off the boot process. The same sector is also duplicated at the very end of the volume, in case the first one goes bad, as is the MFT itself.

Sandwiched between these tiny sections is the filesystem data itself—the stuff the MFT points to. These are your files. When you start a fresh NTFS drive, they're stored quite neatly; a few months or years into the drive's life, they really are not. Files are placed into whatever space the MFT designates as free, and while the system makes a good stab at doing this sensibly, it often needs to break your files apart, and spread them over several areas of free space, with the references to each of the parts stored in the MFT. This is why mechanical drives tend to slow down; the read head needs to jump around the drive to hit each bit of the thing you're trying to load. SSDs don't have this problem, since they can jump between sectors almost instantaneously (relatively speaking, at least).

STAYING SAFE

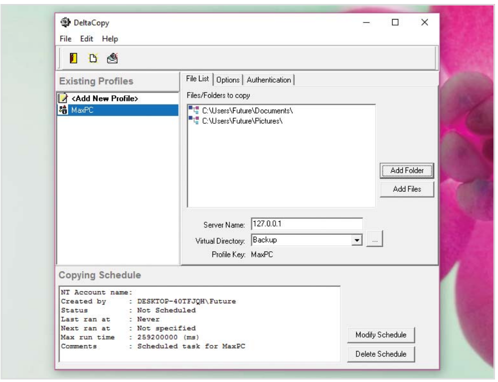
So what does this all mean for you? Well, consider this: When Windows deletes a file, it doesn't do anything to the filesystem data. It merely scrubs the reference from the MFT, and allocates the file's space as "empty." The data itself is still there, almost in its entirety. For now. If the MFT later chooses to store a new file in the same space? Some or all of that deleted file's data will be gone.

This means the first critical step of any data recovery effort (and a

PREVENT DATA LOSS

Recovering files is our aim here, but all of this can be avoided with a sensible computing regime. If you care about your data, build in a backup routine. The prevailing wisdom states that you should follow the rule of three (three copies of your data, stored on at least two kinds of media, at least one of which is kept off-site), and it makes sense to get as close to this as you can. Start duplicating your critical files to a cloud backup service such as CrashPlan, and using external media to keep secondary copies of the most important items. Copying them to another partition on the same drive—or another physical drive in the same machine—is not adequate. Move your backup away from your main machine—to a different floor of your house, perhaps, or even off-site. If you're hit by a flood or a fire, your insurance might buy you a new PC, but it won't cover your files.

An automated process is best—again, something that CrashPlan and its ilk offer—because it pulls vital files when you're not using your machine, ensuring they're duplicated when disaster strikes. If you don't want to pay for a subscription, it's plausible to back up small pockets of files on free services such as Google Drive or Microsoft's OneDrive, but unless you're organized with your local and mirrored folders, you're one step away from a forgetful accident. If you want to take it further, and customize your own backup solution, check out Linux app rsync (https://linux.die.net/man/1/rsync), which has a Windows wrapper in the form of DeltaCopy (www.aboutmyip.com/AboutMyXApp/DeltaCopy.jsp)—you won't find a more versatile app when it comes to cloning data.



Files/Folders to copy

C:\Users\Future\Documents\
C:\Users\Future\Pictures\

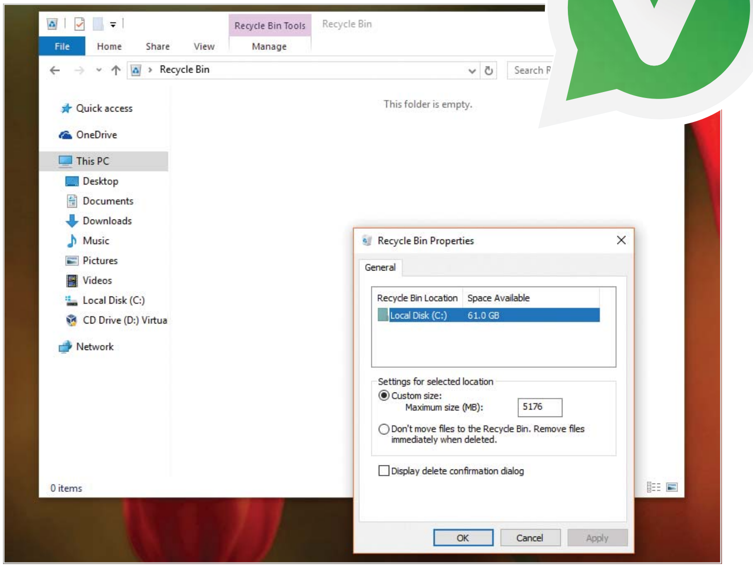
Server Name: 127.0.0.1
Virtual Directory: Backup
Profile Key: MaxPC

```
NT Account name:
Created by     : DESKTOP-40TFJQH\Future
Status         : Not Scheduled
Last ran at    : Never
Next ran at    : Not specified
Max run time   : 259200000 (ms)
Comments       : Scheduled task for MaxPC
```

DeltaCopy makes scheduling backups quick and easy.

point we're going to keep making) is to stop what you're doing immediately, and power down the drive. Don't risk any of your data being inadvertently overwritten, because if you want it back, you want it intact. Usually, you'd shut down your machine using the regular Windows shutdown procedure, which is certainly the optimal choice if your problem is hardware failure, rather than a filesystem glitch. It means your drive's heads (if it has them) are properly and safely disengaged, and any write operations completed properly, thus avoiding potentially corrupted files.

But there's an issue with this: If you have Windows updates waiting, shutting down in the regular way is essentially giving Microsoft license to begin overwriting swathes of your drive's precious bytes with patches that are, at least in the current circumstances, less than helpful. So if you've headed for the Start menu to shut down, and you're getting the dreaded "and update" suffix, it's time to do something we'd ordinarily never recommend: cut the juice. Don't even hold down your power button for 10 seconds—cut the power at the wall, flick the switch on your PSU, or pull the battery if you can. The next time we use this drive, it'll ideally be in read-only mode, which mitigates most of the risk to your data.


Recycle Bin Properties

Recycle Bin Location: Local Disk (C:) — Space Available: 61.0 GB

Settings for selected location

● Custom size: Maximum size (MB): 5176

○ Don't move files to the Recycle Bin. Remove files immediately when deleted.

☐ Display delete confirmation dialog

Expand your Recycle Bin's storage limit via the "Manage" option.

VITAL PREPARATION

What's gone wrong? We don't know for sure. You might, though. The structure of your drive means there are a few potential points of failure—the MBR, the partition table, the MFT, a problem with bad sectors in the file storage area—and that's not to mention mechanical issues, a problem with your motherboard's drive controllers, a malicious attack, or the ultimate destroyer of files: you. We'll come to human error later on. For now, we need to help the people who haven't done something silly.

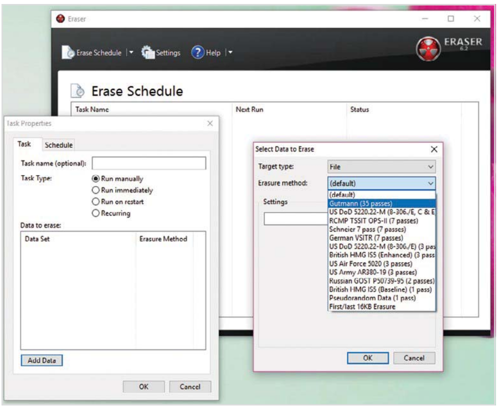
If you have a donor machine you can hook the drive up to (as a secondary drive), that's the ideal. If you don't have that luxury, you need to cross your fingers that your file loss isn't being caused by a malfunction on your current machine. Keep it powered down for now. Whatever the situation, have a fresh external drive ready to transfer any recovered files to, and

STOP RECOVERY FOR GOOD

We've discussed the ways in which your drive stores files, and how they don't really get removed when you delete them or format your drive. What if there are files on there that you really want to stay deleted, and be excluded from any recovery efforts? We can use a little of our knowledge of file storage to work out how to obliterate old data—the best way to make sure files don't rise from the dead is to ensure that "free" space on your drive is completely overwritten. You could painstakingly write files to your drive until it's full, but that's madness. Better to use a secure deletion tool.

You have a few choices here, but we tend to favor Eraser (https://eraser.heidi.ie), which goes overboard in its efforts, overwriting your files several times with specific random data patterns in order to remove them—and, on magnetic drives, the microscopic traces they leave behind—completely. We recommend you keep it hanging around—you can securely delete files just by dropping them on the app, or even have it grind through any unused space on your partitions, applying its algorithms to that space to scrub it clean of any ghostly data.

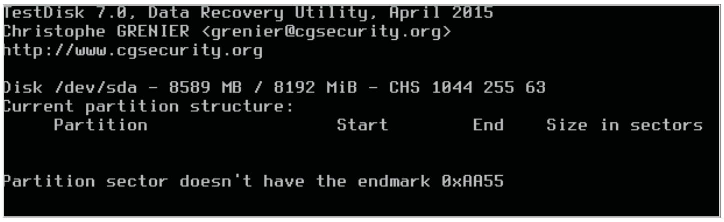
If you really want to get rid of all the data on a drive—if you're passing your hardware on or recycling it, say—System Rescue CD includes the tool Wipe (http://wipe.sourceforge.net), which does an intense, thorough, repeated overwriting of every byte of data on a drive. Or if the hardware doesn't matter, and you're absolutely desperate to get rid of it, do as one of *Maximum PC's* alumni once did: Take a hammer to your drive, and throw it in a lake. But think of the fish before you do it.


Task Properties — Task Type: ● Run manually ○ Run immediately ○ Run on restart ○ Recurring

Select Data to Erase — Target type: File; Erasure method: (default)

(default)
Gutmann (35 passes)
US DoD 5220.22-M (8-306./E, C & E
RCMP TSSIT OPS-II (7 passes)
Schneier 7 pass (7 passes)
German VSITR (7 passes)
US DoD 5220.22-M (8-306./E) (3 pas
British HMG IS5 (Enhanced) (3 pass
US Air Force 5020 (3 passes)
US Army AR380-19 (3 passes)
Russian GOST P50739-95 (2 passes)
British HMG IS5 (Baseline) (1 pass)
Pseudorandom Data (1 pass)
First/last 16KB Erasure

Eraser can make up to 35 passes over your data for absolute removal.

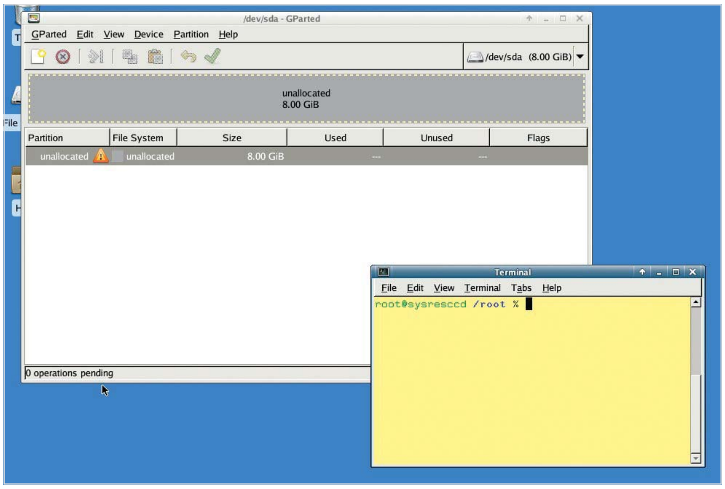


```
TestDisk 7.0, Data Recovery Utility, April 2015
Christophe GRENIER <grenier@cgsecurity.org>
http://www.cgsecurity.org

Disk /dev/sda - 8589 MB / 8192 MiB - CHS 1044 255 63
Current partition structure:
     Partition                  Start        End    Size in sectors


Partition sector doesn't have the endmark 0xAA55
```

If you see this ominous message in TestDisk, your partition table is hosed.


/dev/sda - GParted
GParted Edit View Device Partition Help
/dev/sda (8.00 GiB)
unallocated
8.00 GiB
Terminal
File Edit View Terminal Tabs Help

Partition	File System	Size	Used	Unused	Flags
unallocated	unallocated	8.00 GiB	---	---	

0 operations pending

```
root@sysresccd /root %
```

Type "startx" to fire up System Rescue CD's GUI, and access gparted.

be aware that you may need to do a little manual cleaning up after.

Now, head to a second machine. If you're reading this and you haven't actually suffered any data loss as yet, follow this advice anyway: As any good Boy Scout knows, one must always be prepared. On your second machine, download the x86 version of System Rescue CD from www.system-rescue-cd.org, and write it to a CD or USB stick. There are many rescue-focused distros of Linux, but this one—ugly text-based interface and all—is ours.

PARTITION RECOVERY

Time to get some stuff back. Plug in your large external drive, and boot your affected machine from your System Rescue CD media. You may have to head into your UEFI menu and disable Secure Boot before it works. Hit Return to boot with the default options, and you're thrown straight to a command prompt. OK, not the most welcoming introduction, but we don't need graphical finery for these tasks. You may see a suggestion to mount your drive at this point—don't do it. This is a trap for young players; if your partition table is hosed, you're going to want to work on the raw disk first of all. So type "testdisk" and you can begin taking a look at your connected hardware. Don't worry about creating a log file at this point.

You're first given a list of all the connected storage devices—with luck, you'll see the affected drive. If you don't, you can safely diagnose your problem as physical: Meaning there's a cable loose, a power failure, or your drive controller has gone up in smoke. Presuming you do see the drive, take a note of its designation (sda, sdb, and so on) as we'll need this a little later. Ensure it's selected, and hit Return, selecting the "Intel" partition type unless you're working on a particularly odd drive. Now choose "Analyze." One of two things is going to happen now: If your drive is properly structured, it finds the partition table, and lists the partitions—again, take note of these, and those of the external drive you've plugged in for your recovered files. If the partition table of the rogue drive is missing or damaged (TestDisk looks for a particular byte at a particular point on the drive to discover this), you can select "Quick Search" to have it scan your drive, cylinder by cylinder, for the telltale signs of partition divisions. With any luck, it'll find something, and you'll be given the option to restore the partition table. If not, you can choose to do a deeper scan, which is a last-ditch effort; it takes a long time, and stresses a failing drive, but if you have no other option, it's worth a try.

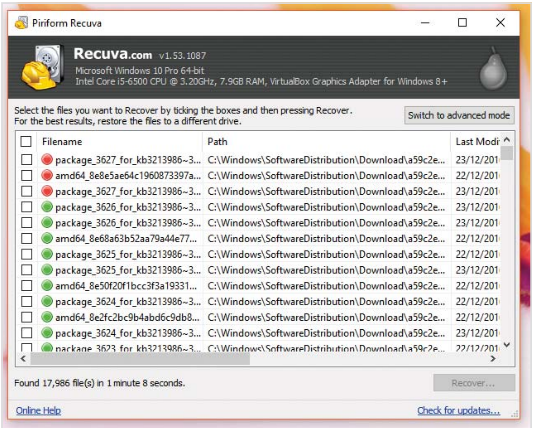
CONNECTING DRIVES

With a healthy partition table, your drive should be in good enough shape to work with—you can now start hunting for your files. TestDisk usefully comes with a companion program, Photorec, the name of which is somewhat out of date—it doesn't just recover photos, but a host of known file types from a selection of over 480. But before we can use it, we need to mount your secondary drive to give it a location to send the files to. Mounting, essentially, is the process of linking a partition of your drive to a Linux file—absolutely everything in Linux is a file—and telling Linux exactly how it should be accessing that drive.

Presuming your backup drive is NTFS formatted, we can use a program called ntfs-3g to do the mounting. First, create a mount point—the folder location that'll represent your drive—by typing `mkdir /mnt/ntfs` at the prompt. Then (replacing "sdb" with the partition designation that you made a note of earlier) type `ntfs-3g /dev/ sdb1 /mnt/ntfs` to solidify the link between the two locations, and bear in mind that you will need the backup drive to be in good working order, too—if ntfs-3g detects bad sectors or NTFS errors, it forces it into read-only mode. Now fire up Photorec by typing `photorec` at the prompt.

FILE RECOVERY

This is the real meat of file recovery. Photorec uses technical knowledge of partition anatomy and the exact



Microsoft Windows 10 Pro 64-bit
Intel Core i5-6500 CPU @ 3.20GHz, 7.9GB RAM, VirtualBox Graphics Adapter for Windows 8+

Select the files you want to Recover by ticking the boxes and then pressing Recover.
For the best results, restore the files to a different drive.

☐	Filename	Path	Last Modi
☐	● package_3627_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	23/12/201
☐	● amd64_8e8e5ae64c1960873397a...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201
☐	● package_3627_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	23/12/201
☐	● package_3626_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	23/12/201
☐	● package_3626_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	23/12/201
☐	● amd64_8e68a63b52aa79a44e77...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201
☐	● package_3625_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201
☐	● package_3625_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	23/12/201
☐	● amd64_8e50f20f1bcc3f3a19331...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201
☐	● package_3624_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201
☐	● amd64_8e2fc2bc9b4abd6c9db8...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201
☐	● package_3624_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	23/12/201
☐	● package_3623_for_kb3213986~3...	C:\Windows\SoftwareDistribution\Download\a59c2e...	22/12/201

Found 17,986 file(s) in 1 minute 8 seconds.

Piriform Recuva is a good low-effort solution for deleted data.

bytes that make up certain file types to skim through your drives and automatically pull off corrupted or lost files. And while its interface is incredibly ugly, it's the most effective tool going. Once you've started it up, pick your affected drive (Photorec only works in read-only mode, so it's safe), choose the partition that you noted earlier, and select "Search." Photorec asks for a location to save its restored files to—navigate through the Linux file tree to find the mount point we made earlier, and pick a folder on your drive if you have one prepared. Hit C when you're done. Photorec now sifts through your drive looking for broken, deleted, or incomplete files, and does its best to recover them fully—grab a cold one, because this is going to take a while. All being well, you should have the majority, if not all, of your stuff back at this point.

There are simpler ways to get the job done. You're welcome to stick within Windows and try running the portable version of Piriform's Recuva from a USB stick (www.piriform.com/recuva/builds), which offers a pretty interface and the option to select precisely what you've lost, rather than just batch-copying everything, but it's more limited to inadvertently deleted files, and isn't particularly helpful if you have an ongoing malware issue. There are also overkill methods—for instance, you could, at the other end of the spectrum, use partimage (included with System Rescue CD) to pull off a full bit-for-bit copy of your affected drive, preserving it for later forensic analysis. Check the guide at www.partimage.org/Main_Page to see how it's done—you can compress the image as it goes, fitting it on to a smaller drive than the source, and later restore it if you suspect hardware failure.

System Rescue CD has one more niche use, too. If Windows itself has given up the ghost, and is blocking your access to your otherwise perfectly stored files, you can mount both your original and backup drives, and copy them off directly. Alternatively, and this may be a slightly more comfortable option, you could boot up another Linux live distro—the likes of Ubuntu—and manually back up using a graphical interface.

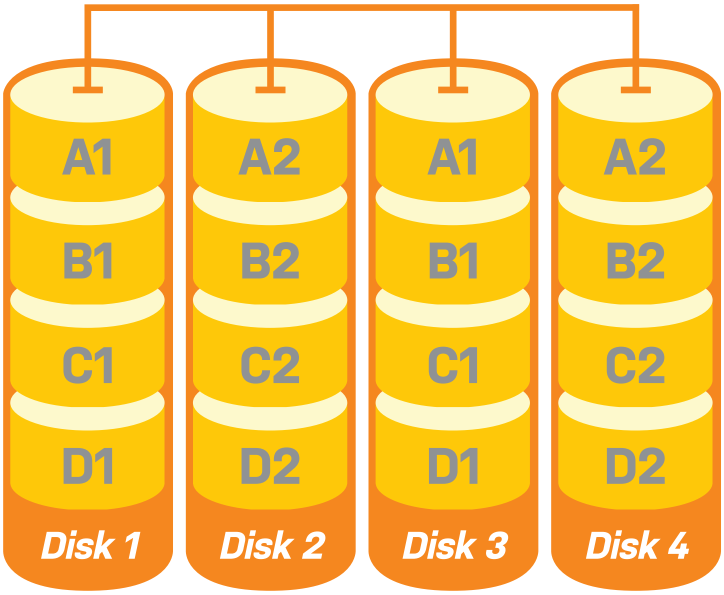
Opened up a drive like this? Then don't expect to get your data back.

WHAT ABOUT RAID?

RAID drives, as you might imagine, can be tricky beasts to recover data from, and certain configurations introduce issues of their own. Run a striped set in RAID 0 formation, for example, and you're asking for trouble—yes, you'll have some of the fastest storage going, but if one of your drives goes down, you're stuck. There are various options that claim to be able to recover files from RAIDs 0, 5, and 10—ReclaiMe (www.freeraidrecovery.com) is the most prominent—but don't hold your breath for any decent results. On the flipside of the coin, RAID 1 and similar mirrored configurations positively aid in data recovery; if one of your drives goes down, you may need to invest a little time and money in remirroring with a new drive, but catastrophic failure is only going to come from your own hand or a malware attack. If this is the case, you have the same chance to recover files as you would with a single drive.

The other issue RAID introduces is the controller itself. If whatever's managing your RAID configuration—your NAS, your main computer, or specialist RAID hardware—goes bad, it could throw your drives into a position where recovering data is entirely impossible. It's not unknown for specialists to be able to engineer specific tools for specific instances of RAID failure, but this is a highly costly procedure, with no guarantee of success.

We don't have an answer for the irony of RAID being both safer and more dangerous than storing on a single drive, other than to suggest, again, that you always keep stringent backups away from your regular hardware.



Want speed and security? Run four drives in Raid 1+0.

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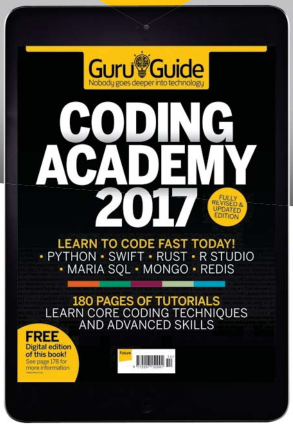

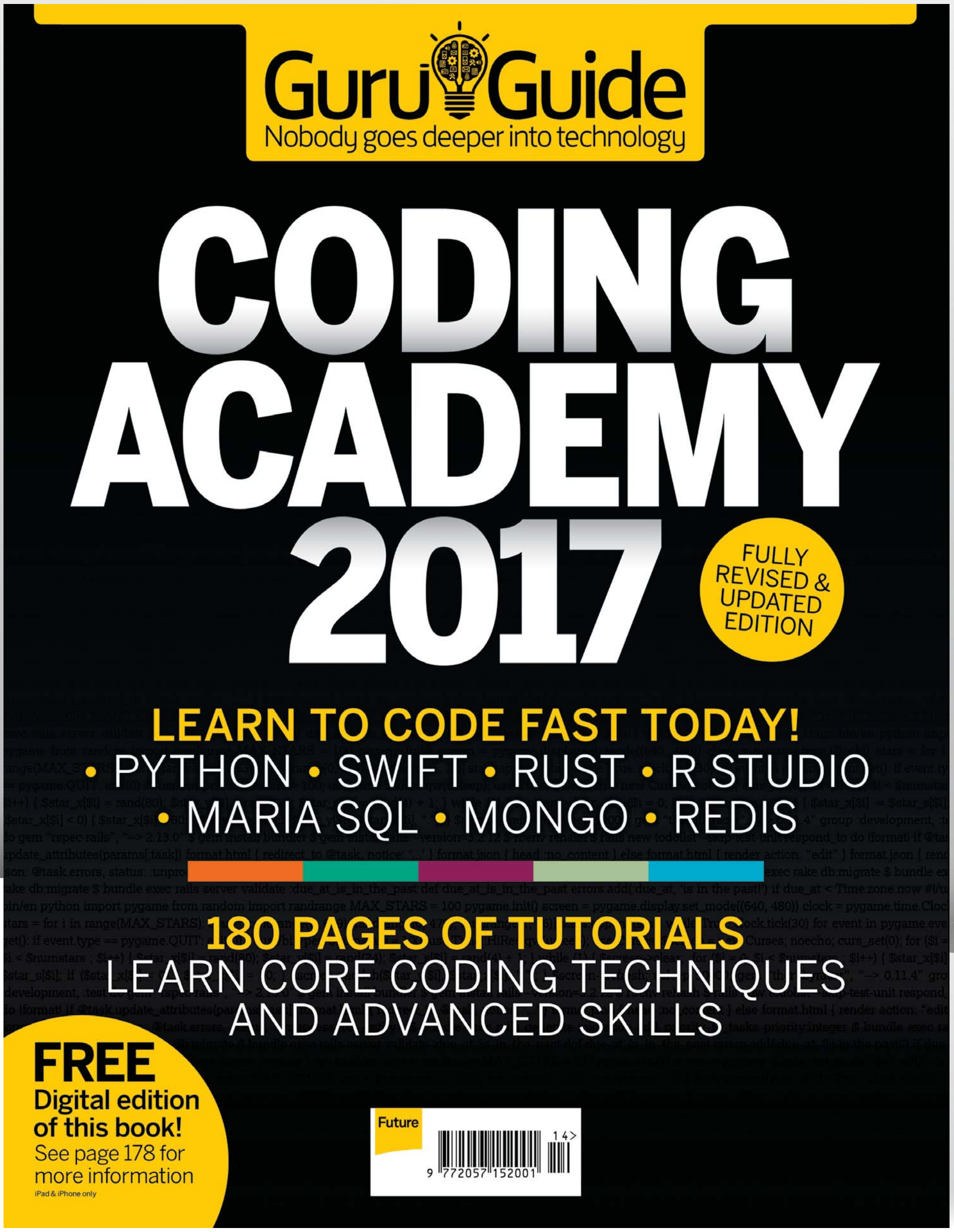

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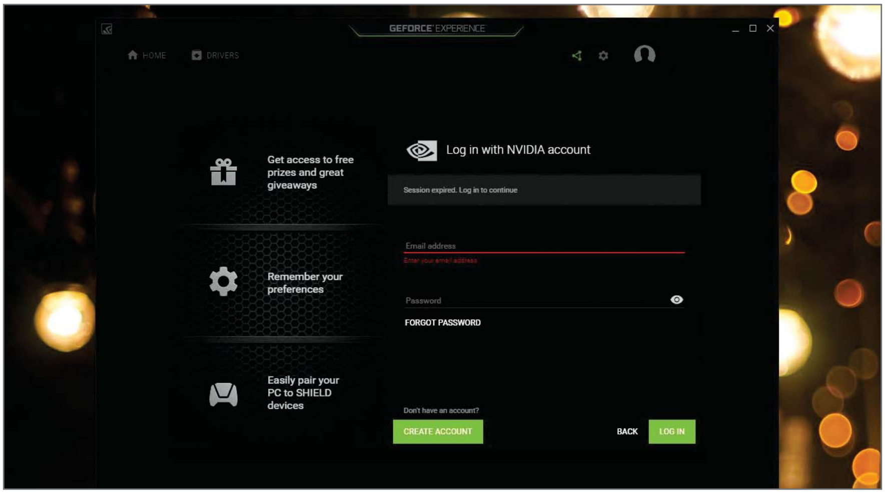
TIP OF THE MONTH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DRIVERS
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Remember your preferences
Easily pair your PC to SHIELD devices
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Email address
Password
FORGOT PASSWORD
CREATE ACCOUNT
BACK
LOG IN

Session expired. Log in to continue

Enter your email address

Don't have an account?

DON'T INSTALL GEFORCE EXPERIENCE

For people concerned about privacy, the latest Nvidia update brought an unwelcome visitor in the form of required account creation to access any features. To counter this, head to www.geforce.com/drivers, manually enter your conditions, and click to download the latest drivers as an EXE. On installation, deselect "GeForce Experience," and you're good to go. Check back monthly or whenever you hear about a new driver release.

MAKE – USE – CREATE

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Set up your own Twitter bot on the Raspberry Pi

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How many cores is enough? Our Build It project finds out

ZAK STOREY
REVIEWS EDITOR

GPU VRAM

Memory seems to be one of the most over-marketed products within the PC enthusiast's arsenal of componentry. Whether it's SSD cache being used to speed up ageing hard drives, enticingly large supplies of GPU memory on a $150 card, or desktop DDR4 with frequencies up into the 4,000MHz range, it tends to be obscured by a barrage of baseless promises.

For example, MSI recently stated that by increasing DDR4 frequencies from 2,400MHz to 4,000MHz, you'd see an in-game improvement in *The Witcher 3* of average frame rates from 94.1 to 114.1. In tests in our March 2016 issue, we saw zero difference in frame rates across 10 memory kits with a 800MHz difference between them.

But my issue lies with graphics memory, and how much is "enough." We had an argument with Asus's PR team regarding the appropriate level of VRAM for various cards. The 4GB 1050 Ti doesn't make sense to us, when the 3GB 1060 is about $30 more, yet performs almost three times better. Asus's argument is that games require ever larger VRAM caches, and you'd be future-proofing yourself by getting a 4GB 1050 Ti over a 3GB 1060.

We disagree. If you game at 1080p, 3GB of VRAM is plenty for any game today. Larger textures don't provide any more detail, and if you're looking to upgrade to higher resolutions, the GPU will become the bottleneck. Don't fall for marketing lies—buy a card with an appropriate amount of VRAM for the resolution and games you play, and build a system around that.

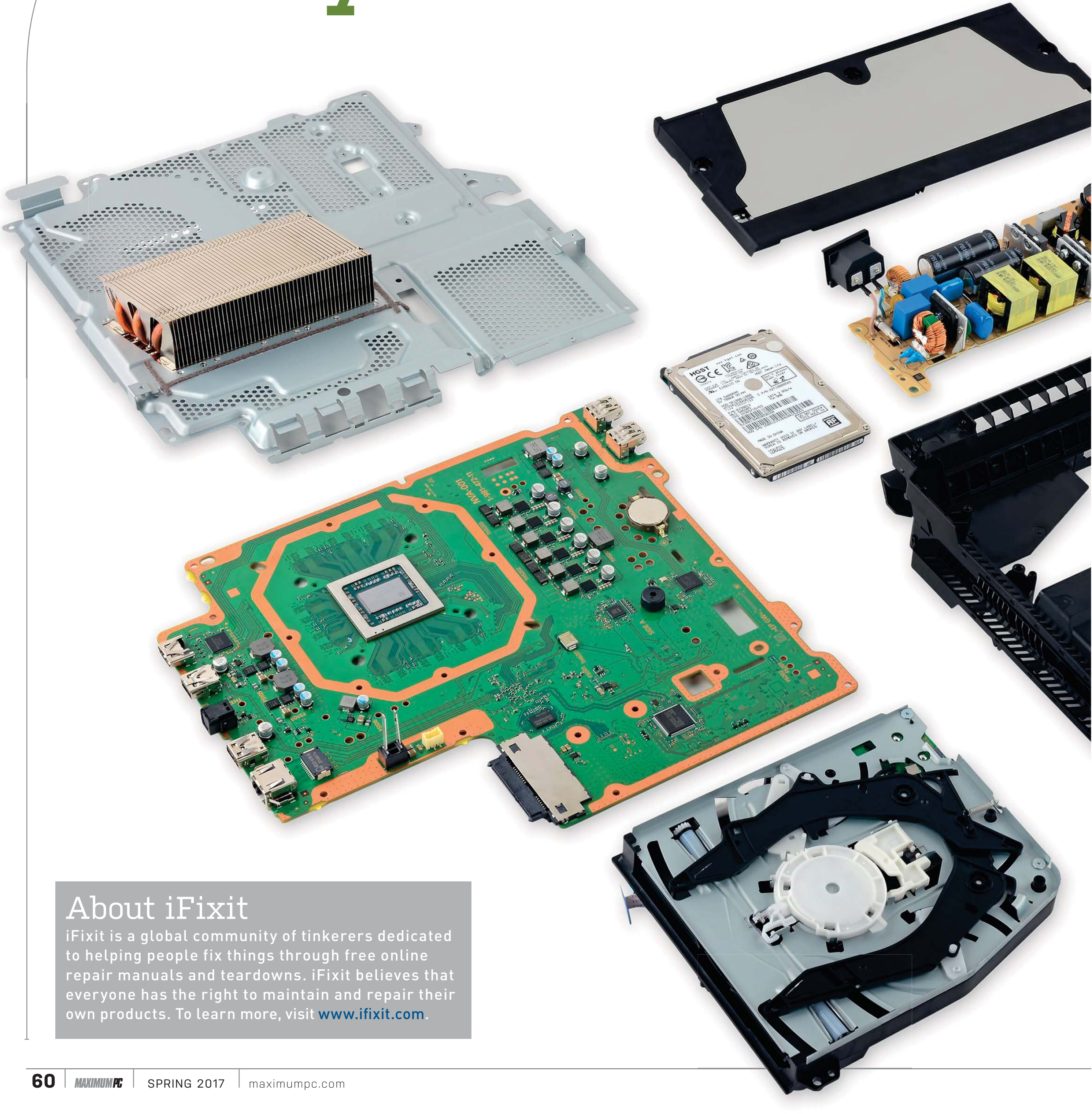
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

PlayStation 4 Pro



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

We're a huge fan of easy-to-remove components.

Fortunately, you can still swap out the hard drive, a PlayStation staple since the PS3.

Remarkably simple, although that's not really surprising.

BACKGROUND

The world of video game platforms has been changing quickly. Manufacturers have resorted to mid-gen refreshes to keep up with 4K TVs and VR headsets, and here's the third iteration of the PS4 generation. We may be amateur gamers, but we're revved up to tear the PlayStation 4 Pro down, professionally.

MAJOR TECH SPECS

- Eight-core AMD "Jaguar" X86-64 CPU, clocked at 2.1GHz (up from 1.6GHz).
- 4.2Tflops AMD Radeon-based graphics.
- 8GB GDDR5 RAM and 1GB DRAM.
- 1TB removable and upgradable hard drive storage.
- 802.11a/b/g/n/ac, Ethernet, and Bluetooth 4.0 (LE).
- Blu-ray x6 CAV, DVD x8 CAV.

KEY FINDINGS

- The triple-decker design is a little different from the "first" PlayStation 4, but that doesn't stop us—without wasting time, we flip the console over, pop the first panel, and hit pay dirt! A single, standard Phillips #0 screw stands between us and hard-drive-swapping glory.
- We're gonna have to remove the "Warranty void if seal removed" stickers to go any further. Adding insult to injury, the screws hidden beneath are Security Torx screws—designed to stop you getting in. With the case cracked open, we can remove a large metal shield. Unfortunately, all this does is give us a view of the motherboard's backside.
- With the beast on its back, the opposite panel pops off after some prodigious prying—but no "warranty void" stickers! Alas, removing this panel isn't the panel-cea we were hoping for. We can pull out the power supply, but nothing else. While you can't remove the fan, you could certainly clean it from here—maybe that's why we're granted this non-warranty-voiding access zone.
- Thwarted by the lack of any more screw heads on the PSU side of the PS4 Pro, we flip it back over and turn our attention to the motherboard. Burrowing through a layer of shielding behind the CPU reveals a cool X-shaped retaining bracket, similar to ones we found in another console. And directly underneath it, we dig up a plastic-and-metal cover that seems to be the consumer electronics version of a pizza saver, protecting the back of the board from the heatsink retaining bracket.
- Repairability Score: 8 out of 10 (10 is easiest to repair). No adhesive makes disassembly and reassembly easy. The non-proprietary hard drive is simple to access and upgrade or replace—and doing so doesn't void your warranty. While you can clean the fan, removing it—and other components—requires lots of (warranty-voiding) disassembly. Security screws and tamper-evident seals discourage users from disassembling and repairing their PlayStation 4 Pro.

Set Up a Twitter Bot On the Raspberry Pi

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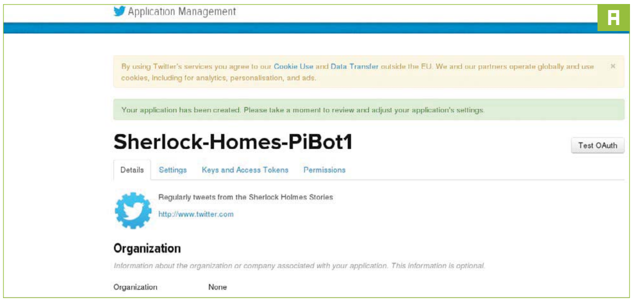
RASPBERRY PI
The brilliant mini-computer costs under $45. See www.raspberrypi.org.

THE SIMPLEST DESCRIPTION OF A TWITTER BOT is a program designed to produce automated posts on Twitter. The most common use for bots is spam. The bot examines key words—cleaning products, for example—then responds with a promotional link for people to click to be taken to the spammer's website. The feature also has non-spammy uses, however. Bots can be programed to search for any word or phrase, and respond accordingly. One entertaining implementation of this was @BDZNappa, which searched for people tweeting the phrase "over 9,000," to which it always responded, "WHAT!? NINE THOUSAND?" Bots can also tweet from a text source, such as @SunTzuBot, which tweets daily quotes from *The Art of War*. More sophisticated bots, such as @JustDiedBot, actively search the Internet for source material. @JustDiedBot searches Wikipedia for information about recent deaths, and tweets RIP announcements as they happen. **–NATE DRAKE**



By using Twitter's services you agree to our Cookie Use and Data Transfer outside the EU. We and our partners operate globally and use cookies, including for analytics, personalisation, and ads.

Your application has been created. Please take a moment to review and adjust your application's settings.

Sherlock-Homes-PiBot1

Regularly tweets from the Sherlock Holmes Stories
http://www.twitter.com

Organization
Information about the organization or company associated with your application. This information is optional.

Organization None

1 PRELIMINARY STEPS

Bots have practical uses, too. They can be programed to tweet at regular intervals, so can be used as a "dead man's switch" to tweet a message unless you reset it every day. It's also possible to schedule a tweet for a future date, so you can use the bot to send out reminders.

›› If you find any of these possibilities intriguing, you need to set up a dedicated Twitter account for your bot. Do not be tempted to use your existing Twitter account for this if you have one, because repeated tweets could be mistaken as spam by Twitter, and your account could be suspended.

›› In order to proceed, we need a new Twitter account with a confirmed cell phone number. If you already have a Twitter account, visit https://support.twitter.com/articles/81940# and follow the steps there to delete your cell phone number from your account for the time being.

2 CREATE NEW TWITTER ACCOUNT AND APP

Next, visit www.twitter.com and choose "Sign Up." You can use any email address you wish, provided it's not already registered with Twitter. Choose a name that is appropriate for the bot. For the purposes of this tutorial, we're creating a bot named Sherlock Bot, with user ID @holmesbot1 [**Image A**].

›› You are asked to provide your cell phone number, and then confirm it by SMS. Twitter requires this for bots to reduce the likelihood of spam.

›› Once your Twitter account has been created, you may need to click "Continue" a few times at the top-right to skip invitations to import your contacts or follow other users.

›› Next, we need to create a Twitter application that allows your Raspberry Pi to access your Twitter account. Go to http://apps.twitter.com, then click "Create New App."

3 INPUT DETAILS

You are asked to fill in the "Application Details." For this tutorial, we're creating a bot that regularly tweets the Sherlock Holmes stories, but you're welcome to change the "Name" and "Description" as you see fit.

›› Under "Website," for now simply put "http://www.twitter.com." Leave the field named "Callback URL" blank. Check the box to say you agree to the Twitter Developer Agreement, then click the gray button marked "Create your Twitter Application."

›› Make sure "Access Level" reads "Read and Write." If not, click "Modify App Permissions" to change it. Next, click on "Manage Keys and Access Tokens." Scroll to the bottom of the page, and click the gray button marked "Create My Access Token."

›› You see a message saying the access token has been generated. Keep a copy of this page in a safe place, or leave it open in your browser, because we'll need it shortly.

4 WORKING ON THE PI

Next, open the terminal app on your Raspberry Pi or connect to it via SSH. We need to install some extra software by using the following command:

```
sudo easy_install pip
```

›› Next, create a directory for the bot and open it:

```
mkdir holmesbot1 && cd holmesbot1
```

›› For this example, we're going to use a Python library created by Edwin Dalmaijer, named Markovbot. The software essentially takes some text from a source (in this case, *The Adventures of Sherlock Holmes*) and randomly constructs plausible-looking sentences with it.

›› You need to download and unzip the software with the following command:

```
wget https://github.com/esdalmaijer/markovbot/
archive/master.zip && unzip master.zip
```

›› Move to the new directory with `cd markovbot-master` and install more required software with these commands:

```
wget https://bootstrap.pypa.io/ez_setup.py && sudo
python ez_setup.py
sudo easy_install twitter
```

›› Next, we need to download a text file to use as the source for our bot's random tweets. This file comes from the Project Gutenberg website, but feel free to use any TXT file you like:

```
wget http://www.gutenberg.org/cache/epub/1661/pg1661.txt
```

» Then we create an empty file to place our code. You can choose any name you like, provided you use the extension `.py` at the end:

```
nano sherlock1.py
```

» Enter the following code in the new file:

```
import os
import time
from markovbot import MarkovBot

# # # # #
# INITIALIZE

# Initialize a MarkovBot instance
tweetbot = MarkovBot()

# Get the current directory's path
dirname = os.path.dirname(os.path.abspath(__file__))
# Construct the path to the book
book = os.path.join(dirname, u'pg1661.txt')
# Make your bot read the book!
tweetbot.read(book)


# # # # #
# TWITTER

# The MarkovBot uses @sixohsix's Python Twitter Tools,
# which is a Python wrapper for the Twitter API. Find it on
# GitHub: https://github.com/sixohsix/twitter

# ALL YOUR SECRET STUFF!
# Make sure to replace the bits in quotation marks below with
# your own values, or try to find a more secure way of dealing
# with your keys and access tokens. Be warned that it is NOT
# SAFE to put your keys and tokens in a plain-text script!

# Consumer Key (API Key)
cons_key = 'yourconsumerkeyhere'
# Consumer Secret (API Secret)
cons_secret = 'yourconsumersecrethere'
# Access Token
access_token = 'youraccesstokenhere'
# Access Token Secret
access_token_secret = 'youraccesstokensecrethere'

# Log in to Twitter
tweetbot.twitter_login(cons_key, cons_secret, access_token,
access_token_secret)
# Start periodically tweeting. This will post a tweet
# every minute.
# (You're free to choose your own interval, but please
# don't use it to spam other people. Nobody likes spammers
# and trolls.)
# This function operates in a Thread in the background,
# so your code will not block by calling it.
tweetbot.twitter_tweeting_start(days=0, hours=0, minutes=1,
keywords=None, prefix=None, suffix='#IamSherlocked')
```

5 ENTER YOUR PERSONAL VALUES

Once the code has been entered, you need to use your arrow keys to navigate to `'yourconsumerkeyhere'`, `'yourconsumersecrethere'`, `'youraccesstokenhere'`, and `'youraccesstokensecrethere'`, and replace these with the values from Twitter's website that you noted down earlier. Leave the quotation marks. You'll also notice the file name `pg661.txt` under the words `Construct the path to the book`, so change the file name to your own text file also.

» Now scroll down to the bottom of the code and note that, by default, this code will tweet once every minute. Change this if you wish—for example, to once a day: `days=1, hours=0, minutes=0`. Finally, you may wish to change the suffix placed after every tweet to something else or to `None`.

» Press Ctrl-X when done, then Y, then Return to save. You can run your script at any time with the command:

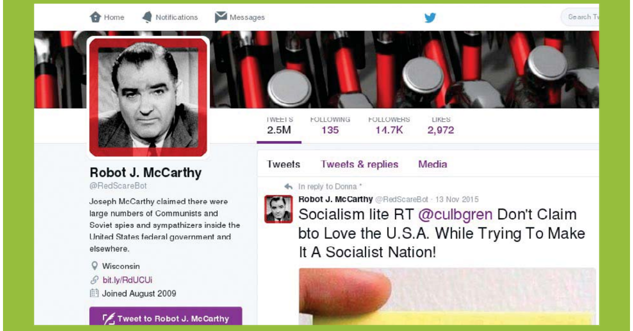
```
sudo python sherlock1.py
```

» Be sure to substitute `sherlock1.py` with the actual name of your file. The terminal will show the tweets but you can also check on the website.

6 GOING FURTHER

There are many more possible Python projects you can do with Twitter, including responding to keywords, automatic retweets, and even grabbing values from web pages, such as stock market prices. Head over to www.raspberrypi.org/blog/tag/python/ to see some of the exciting projects that have been achieved with Python.

BOTS OF NOTE



Robot J. McCarthy
@RedScareBot
Joseph McCarthy claimed there were large numbers of Communists and Soviet spies and sympathizers inside the United States federal government and elsewhere.
Wisconsin
bit.ly/RdUCUi
Joined August 2009

In reply to Donna *
Robot J. McCarthy @RedScareBot · 13 Nov 2015
Socialism lite RT @culbgren Don't Claim bto Love the U.S.A. While Trying To Make It A Socialist Nation!

Bots have been around for several years, and some have thousands of followers. Some of them simply react to words in tweets. For instance, anyone using the phrase "illegal immigrant" can expect a response from @DropthelBot saying, "People aren't illegal. Try saying 'undocumented immigrant' or 'unauthorized immigrant' instead."

The @everyword bot began tweeting every word in the English language in 2007. It tweeted a new word every half-hour until it completed its task in 2014, after 109,157 words.

There are also bots that exist for political parody. Mentioning the words "communism" or "socialism" provokes the ire of @RedScareBot Robot J McCarthy himself, who tells you the "Red Storm is rising" and to "circle the wagons."

@DeepDrumpf is a Twitter bot created by MIT, which uses neural network technology to analyze data and post tweets in the supposed speaking style of Donald Trump. The developers claim the bot was trained via transcripts of Trump's speeches.

The twitter bot @factbot1 makes good use of images. Creator Eric Drass programed the bot in response to the tendency of some people to believe unproven facts, provided they're accompanied by an image. The bot regularly tweets nearly true and nonsensical facts. One such "fact" is that the Canadian government derives 38 percent of its income from the sale of donuts. This is plausible, given the ubiquity of Tim Hortons cafés in the land of the maple leaf, but sadly false.

Colorize Black and White Photos

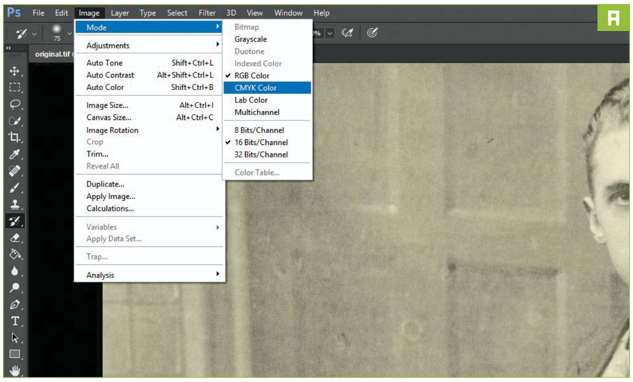
YOU'LL NEED THIS

PHOTOSHOP
Available from www.adobe.com.

MONOCHROME IMAGE
Scour your family collection.

ONCE, THE WORLD WAS BLACK AND WHITE. Created by MGM for *The Wizard of Oz* (a film cruelly overlooked at the Oscars in favor of *Gone With the Wind,* which invented wind), color wouldn't become mainstream technology until halfway through the 20th century, and even then pockets of resistance lingered, where people refused to install the relevant upgrades, claiming that monochrome was good enough, and that they didn't trust the free update not to give their eyes typhoid.

Pity the PC owner in this world of perpetual twilight. The twinkling LEDs in his keyboard could only show shades of gray, Hercules made all graphics cards (they were fairly high res though), and people weren't really certain about dithering. Artifacts of this time still exist in the form of black and white photos, but we can bring them into the present with a little image editing. Colorizing a mono photo can never bring back the true colors from the moment it was taken, but it can have a charming look all of its own. –IAN EVENDEN


A
Ps
File
Edit
Image
Layer
Type
Select
Filter
3D
View
Window
Help
75
original.tif
Mode
Adjustments
Auto Tone Shift+Ctrl+L
Auto Contrast Alt+Shift+Ctrl+L
Auto Color Shift+Ctrl+B
Image Size... Alt+Ctrl+I
Canvas Size... Alt+Ctrl+C
Image Rotation
Crop
Trim...
Reveal All
Duplicate...
Apply Image...
Calculations...
Variables
Apply Data Set...
Trap...
Analysis
Bitmap
Grayscale
Duotone
Indexed Color
✓ RGB Color
CMYK Color
Lab Color
Multichannel
8 Bits/Channel
✓ 16 Bits/Channel
32 Bits/Channel
Color Table...

1 CHANGE COLOR FORMAT

Open your image file in Photoshop. If you've scanned a black and white photo or photographed it, you've probably got a file that uses the RGB color format, which means each pixel is defined by values of red, green, and blue. We're going to change this to CMYK, the format used in printing things like this magazine, for no other reason than we were messing around with the file, and we discovered it works better this way. Head to "Image → Mode → CMYK color" [**Image A**] and make the change—nothing should happen to your image, but the color format information up by the file name alters.

2 CREATE A SKIN TONE

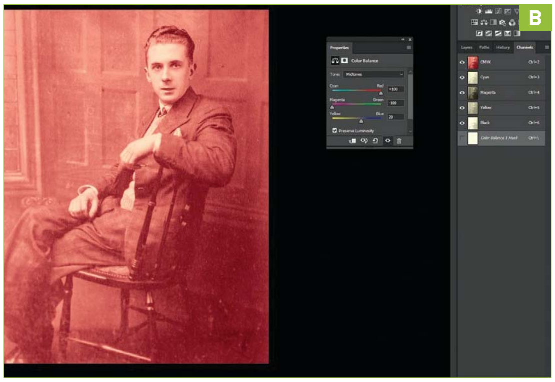
Now we're going to create the colors that will be used in the image. First, go to the History palette, and create a new snapshot of your original image. To do this, right-click the most recent History state (probably "CMYK color"), and select "New Snapshot." Select "Merged Layers" from the drop-down, give it a name (such as "Original"), and click "OK." Now, on the right of Photoshop's interface, you should find the Channels palette. If it's not there, open it from the Window menu. In the palette, select the Cyan channel, and select a "Brightness/Contrast" adjustment from the Adjustments palette (find it in the Window menu if it's not visible). Use this to brighten the channel and increase its contrast, and hopefully you should get something resembling a skin tone (we're assuming that your photo has a person in it, because these are the most common subjects for the colorization treatment). Close the window when you're done.

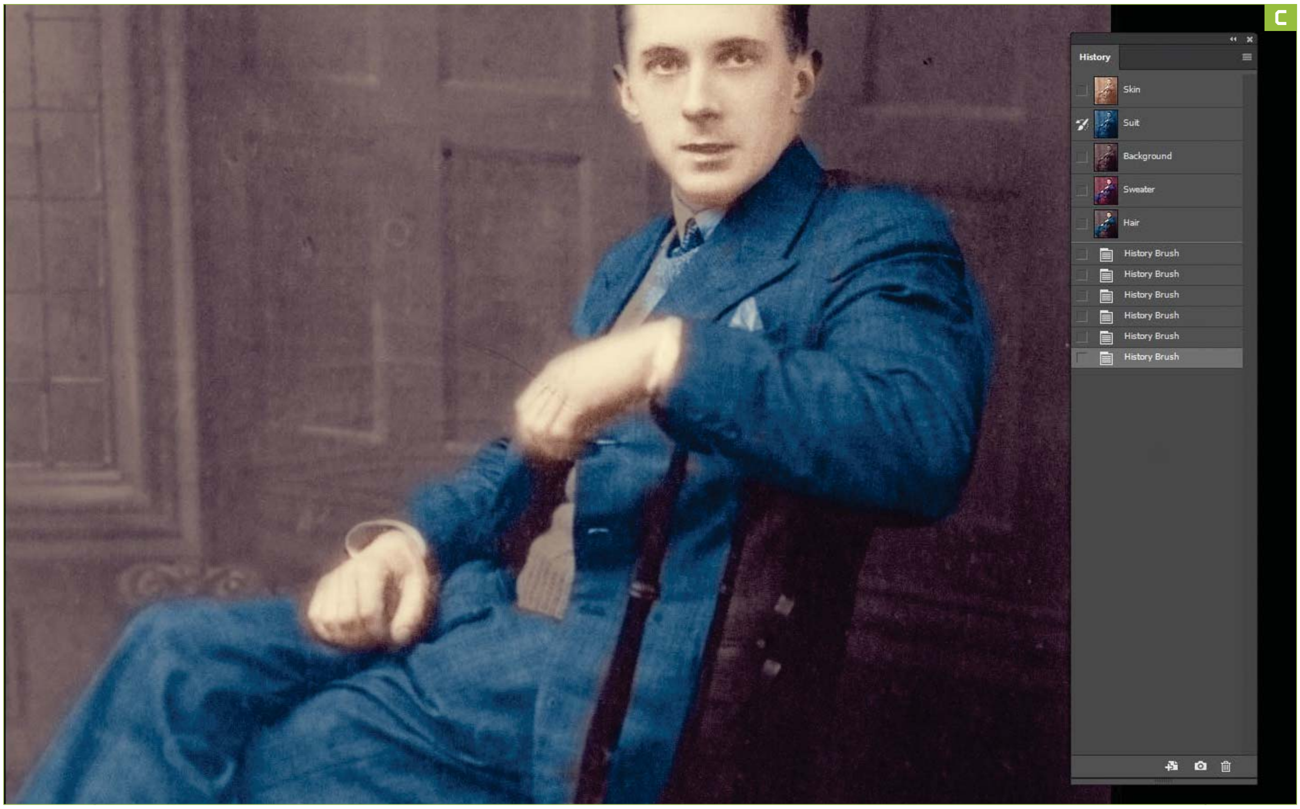
3 MAKE MORE COLORS

Create a new snapshot just as you did in step two, and call this one "Skin." You'll see the snapshots stack up above the History palette as you work. Next, create some colors that would be appropriate for the other objects and areas in your photo. We're going to make them for the gentleman's suit, his hair, his sweater, and a general background color, but you can make as many as you need. To do this, we're going to use the Adjustments palette again, but this time using the "Color Balance" adjustment, the icon for which looks like a tiny pair of scales [**Image B**]. When you open it, you'll find color sliders that are paired off, so you can slide them between cyan and red, for example, or yellow and blue.

4 COLOR EACH AREA

Look at the area you want to color, and mess with the sliders until it's the hue you want, or at least an acceptable color if finding the exact shade is proving difficult. You'll notice that your changes affect the entire image, changing the skin tone color you created earlier, but this doesn't matter. When you've finished, create another new snapshot, naming it appropriately. Go on to do this for every color you want to use. Planning ahead is essential at this stage, because it's tricky to come back later and create a new color without undoing a lot of your work. It's worth making sure that the snapshot with the largest areas of coloring on is created last, because this saves time.





5 USE THE HISTORY BRUSH TOOL

The next stage requires a steady hand and can take some time. We're going to use a paintbrush tool to merge all the snapshots we created into one image, making sure the colors go in the appropriate places. Thanks to the mono nature of our source, the shading is taken care of for us—we just have to make sure we don't paint over the edges too much. Select the newest snapshot in the stack, usually the one at the bottom, and make sure that you've selected an image layer in the Layers palette, and not an adjustment layer. Back in the History palette, click the checkbox at the side of one of the other snapshots—it should appear like a brush with an arrow next to it; this is the History Brush tool.

6 START PAINTING

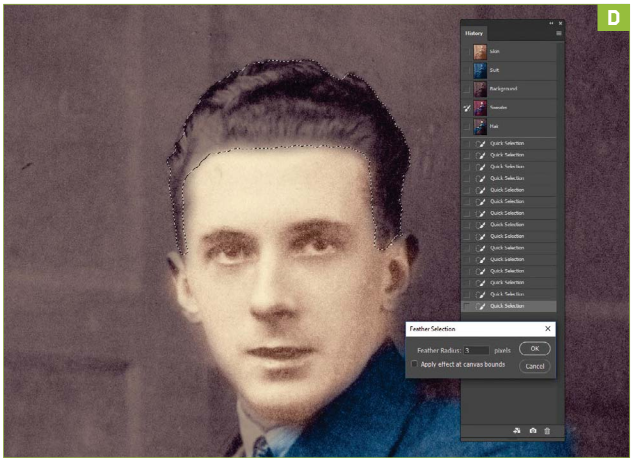
Now, as you paint, the colors from the checked layer should be painted on to your selected layer [**Image C**]. Paint in short bursts, so you can use Ctrl-Z to undo any mistakes you make, and use a selection tool to help you stay in the right area if you need to. Feathering the edge of the selection (Shift-F6) by a few pixels [**Image D**] can create a soft border between colors if it's looking a little harsh. Make sure you save repeatedly as you go, and it can be worth creating extra Full Document snapshots as you work, because the History Brush process can do strange things to your History palette.

7 FINISHING TOUCHES

This can be a painstaking process, but it's worth doing for a result you can proudly present to an aged relative. When you've finished, save the layers as a PSD file, then flatten it, convert back to RGB, and export as a JPEG ready for printing. ⏻

CMYK COLOR

CMYK is used in commercial printing, and splits an image into cyan, magenta, yellow, and key (black), which represent the inks mixed on the press to create any other color. Most images designed to be viewed on a screen are RGB, which uses a mixture of red, green, and blue light, to achieve the same effect. Monitors, which operate in RGB, don't always accurately represent CMYK colors, especially where reds are concerned, but a system of color profiles and screen calibrators means colors can be kept consistent across screens and on to the press. We've only used CMYK here, because it made one step easier—you'll want to convert back to RGB before you finish, and not just because CMYK files can be significantly larger than RGB ones.



Feather Radius: 3 pixels

☐ Apply effect at canvas bounds

Boost Your NAS With Link Aggregation

YOU'LL NEED THIS

LACP-CAPABLE NAS
Look for two Ethernet ports on the back.

SMART SWITCH
This needs to support LACP, too.

DOES YOUR NAS DRIVE come with two Gigabit Ethernet ports? When plugged into a compatible switch, the two ports enable you to combine the two connections using technology called "link aggregation" or "port trunking." Link aggregation is a catch-all term for various methods of providing a parallel network connection through multiple Ethernet ports. One basic use is to provide a layer of redundancy—if one port fails, the other can still be used. But a more exciting—and practical—use for link aggregation is LACP (Link Aggregation Control Protocol).

LACP increases the throughput of your NAS drive, which means you can speed up the shoveling of data to and from the drive. Hurrah, you cry: double the transfer speed! Sadly, no. You can't increase the speed of a single network connection using LACP, but you can increase the available bandwidth for multiple connections. This helps when two or more users attempt to access the drive at once—for example, uploading and downloading files at the same time, or attempting to run two movie streams simultaneously, which is why it's often referred to as "load balancing." Read on to discover what equipment you need, how to configure it, and how to test your tweaks. **–NICK PEERS**

A
QNAP
STATUS
LAN
USB
HDD1
HDD2

1 CHOOSE THE RIGHT DRIVE

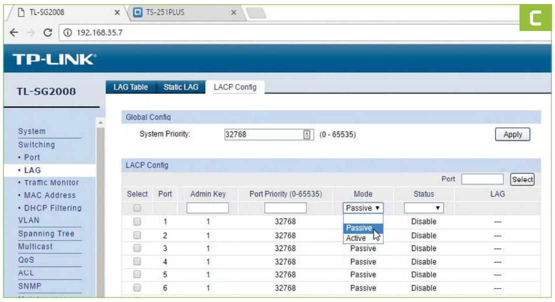
If your NAS drive [**Image A**] has twin Ethernet ports, check its manual or specs to see what forms of link aggregation it supports. Most drives should offer LACP support, although the terminology varies between manufacturers: QNAP and Synology drives refer to "802.3ad dynamic," for example. If your drive doesn't support LACP, check to see whether it provides its own proprietary form of load balancing—see the "Wot, No Link Aggregation?" box on the right for details.

» If you're in the market for a LACP-compatible drive, look for a higher-end SOHO or small business model—QNAP's TS-231+ is around $170 diskless, for example.

2 BUY THE RIGHT SWITCH

Most home routers don't come with link aggregation support on board. The most cost-effective way to add link aggregation support to your home network is through a managed switch [**Image B**]. It's important that you carefully check the link aggregation features offered by your chosen switch, because cheaper models may not have all the features you need (as we've discovered to our cost). For example, TP-Link's TL-SG108 model costs under $30, but doesn't support LACP. Instead, you need to shell out $69 for the next model up, TP-Link's SG-T2008, which we're using as the focus of this tutorial. If you're using a different model, you need to adapt the steps according to your switch's instructions.

B
TP-LINK
TL-SG2008
8-Port Gigabit Smart Switch
Power
System
1
2
3
4
5
6
7
8
1000Mbps
10/100Mbps
Reset



192.168.35.7

TL-SG2008

Global Config

System Priority: 32768 (0 - 65535)

LACP Config

Port

Select	Port	Admin Key	Port Priority (0-65535)	Mode	Status	LAG
☐				Passive ▾	▾	
☐	1	1	32768		Disable	---
☐	2	1	32768		Disable	---
☐	3	1	32768	Passive	Disable	---
☐	4	1	32768	Passive	Disable	---
☐	5	1	32768	Passive	Disable	---
☐	6	1	32768	Passive	Disable	---

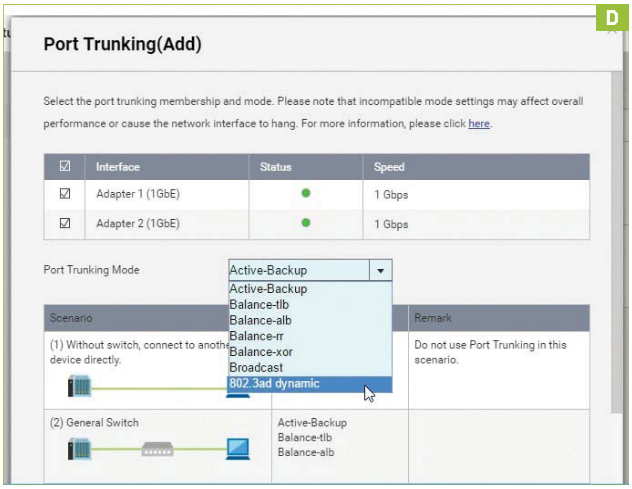
3 BENCHMARK THE DRIVE

Take a rough and ready "before" benchmark by copying a large multi-gigabyte file, such as a drive image, to or from the NAS. Make a note of the transfer speed. Now repeat the process using two separate PCs or Macs, and you should find the transfer speed is roughly halved on each device, illustrating the current bottleneck.

4 IDENTIFY IP ADDRESS AND LOG ON TO SWITCH

First, verify that your NAS's Ethernet cables don't need to be plugged into specific ports for link aggregation support (any ports can be used on the TL-SG2008, so we've plugged our NAS into ports 7 and 8, the two closest to the power switch).

» Smart switches are managed one of two ways: either through a third-party utility, or (in the case of TP-Link's TL-SG2008 model) through your web browser. Type its IP address into your web browser, then log on using the required credentials (if you haven't previously logged on to the switch, use the manufacturer defaults, then change them for security reasons). If you're struggling to identify your switch's IP address, use a tool such as Fing (www.fing.io) to locate it.



Port Trunking(Add)

Select the port trunking membership and mode. Please note that incompatible mode settings may affect overall performance or cause the network interface to hang. For more information, please click here.

☑	Interface	Status	Speed
☑	Adapter 1 (1GbE)	●	1 Gbps
☑	Adapter 2 (1GbE)	●	1 Gbps

Port Trunking Mode: Active-Backup

Scenario		Remark
(1) Without switch, connect to anothe… device directly.		Do not use Port Trunking in this scenario.
(2) General Switch	Active-Backup Balance-tlb Balance-alb	

WOT, NO LINK AGGREGATION?

Even if your switch or router doesn't support link aggregation, your NAS drive should still be able to support some limited form of load balancing through its twin Ethernet ports using proprietary technologies built into the NAS itself. Check the port trunking or link aggregation settings for a load balancing option that doesn't require link aggregation: WD MyCloud users should try the "Round Robin" setting, while Synology boxes refer to "Adaptive Load Balance," and QNAP users should look for "Balance-alb." These settings should support load balancing and redundancy, so if one port fails, the other continues to function. Attach each port to a different switch, and the connection is maintained even if one switch fails.

5 SET UP LACP

Once logged in, click "Switching" on the left to expand the submenu, then click "LAG." You'll see three tabs across the top—switch to the "LACP Config" tab. Check the two ports your NAS is plugged into ("7" and "8" in our case), set the "Status" drop-down menu to "Enable," and click "Apply." Check both boxes again, set mode to "Passive," then click "Apply" again [**Image C**].

›› Ports 7 and 8 should now have "LAG1" under the "LAG" column. Switch to the "LAG Table" tab, and verify it's set to "Passive LACP," and the "Hash Algorithm" drop-down is "SRC MAC + DST MAC."

›› Again, the steps vary for other setups—consult your switch's documentation to see how to implement a passive LACP system on the switch for the ports your NAS is plugged into.

6 SET UP NAS

Open a new tab and log into your NAS through your browser. Locate the link aggregation or port trunking section—QNAP users should go to "Control Panel → System Settings → Network & Virtual Switch," then select "Interfaces," and click "Port Trunking." Click "Add," check both adapters, click the "Port Trunking Mode" drop-down, and select "802.3ad dynamic" [**Image D**]. Click the edit button and verify "Layer 2 (MAC)" is selected. Click "Apply."

›› Synology users can find step-by-step instructions at www.synology.com/knowledgebase/DSM/help/DSM/Tutorial/home—look under "Control Panel → Connectivity → Network → Link Aggregation."

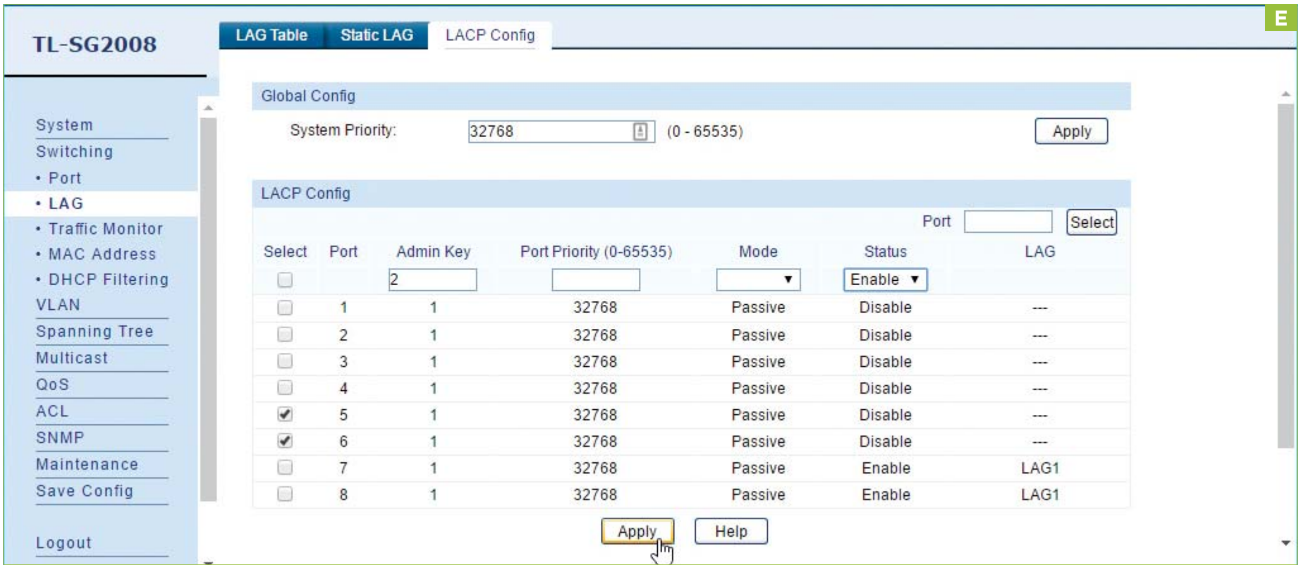
7 TEST CONNECTION AND TWEAK SETTINGS

Repeat your benchmarks—there's now little or no difference when one PC accesses the drive, but the drop-off when two PCs are connected should be greatly reduced (if not eliminated). If this isn't the case, double-check your settings—LACP should be enabled, but passive, on the switch side, and just enabled on the NAS side.

8 SPEED UP SINGLE CONNECTIONS

We lied when we said it isn't possible to speed up transfer times between your NAS and a single PC using LACP, but it requires a lot more effort. Find out more with our editor-in-chief's handy online guide at www.pcgamer.com/how-to-set-up-nic-teaming-link-aggregation—just ask yourself if it's worth it, though.

›› One tip if you go down this route—if you're using the TL-SG2008 to set up multiple LACP connections, assign a different Admin Key to each separate LAG pairing you set up [**Image E**]. When repeating step five of the walkthrough, set the Admin Key to "2" for this new grouping, which should identify itself as LAG2 when done. ⏻



Global Config

System Priority: 32768 (0 - 65535) Apply

LACP Config

Port: Select

Select	Port	Admin Key	Port Priority (0-65535)	Mode	Status	LAG
☐		2			Enable	
☐	1	1	32768	Passive	Disable	---
☐	2	1	32768	Passive	Disable	---
☐	3	1	32768	Passive	Disable	---
☐	4	1	32768	Passive	Disable	---
☑	5	1	32768	Passive	Disable	---
☑	6	1	32768	Passive	Disable	---
☐	7	1	32768	Passive	Enable	LAG1
☐	8	1	32768	Passive	Enable	LAG1

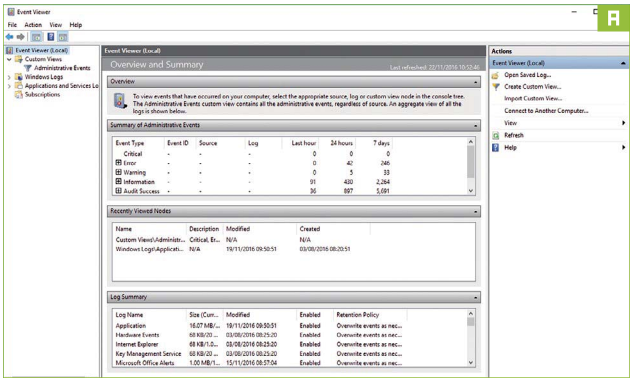
Stop Your PC From Crashing

YOU'LL NEED THIS

A WINDOWS PC
Running Windows 7, 8, or 10.

WHY IS IT THAT YOUR PC always seems to develop problems at the most inopportune moments? While Windows is pretty good at fixing its own problems, there are still frustrating times when its own built-in tools, from self-healing to troubleshooters, fail to do the job.

There's still no substitute for the self-help approach, and one of the best tools for this is the Event Viewer. It's where you'll find Windows' log files, a record of everything that's going on, including symptoms of problems both evident and still hidden away. By carefully examining these logs, you can find out what's causing all kinds of glitches, from obvious—if cryptic—error messages to more vague issues, such as sluggish behavior or periodic freezes. This tutorial can help you decipher these logs and find a solution to your problem. **–NICK PEERS**



Event Viewer (Local)
Overview and Summary
Last refreshed: 22/11/2016 10:52:46

Overview

To view events that have occurred on your computer, select the appropriate source, log or custom view node in the console tree. The Administrative Events custom view contains all the administrative events, regardless of source. An aggregate view of all the logs is shown below.

Summary of Administrative Events

Event Type	Event ID	Source	Log	Last hour	24 hours	7 days
Critical	-	-	-	0	0	0
⊞ Error	-	-	-	0	42	246
⊞ Warning	-	-	-	0	5	33
⊞ Information	-	-	-	91	430	2,264
⊞ Audit Success	-	-	-	36	897	5,691

Recently Viewed Nodes

Name	Description	Modified	Created
Custom Views\Administr...	Critical, Er...	N/A	N/A
Windows Logs\Applicati...	N/A	19/11/2016 09:50:51	03/08/2016 08:20:51

Log Summary

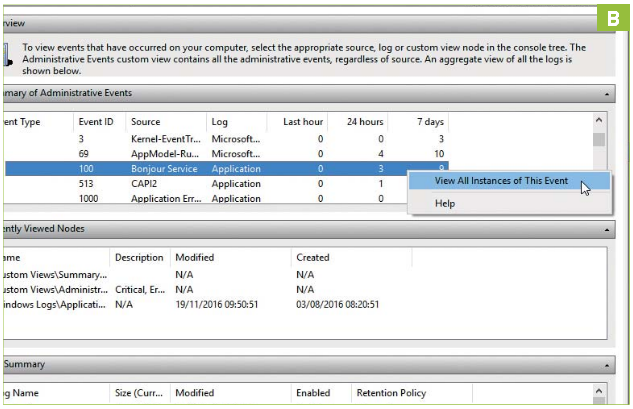
Log Name	Size (Curr...	Modified	Enabled	Retention Policy
Application	16.07 MB/...	19/11/2016 09:50:51	Enabled	Overwrite events as nec...
Hardware Events	68 KB/20 ...	03/08/2016 08:25:20	Enabled	Overwrite events as nec...
Internet Explorer	68 KB/1.0...	03/08/2016 08:25:20	Enabled	Overwrite events as nec...
Key Management Service	68 KB/20 ...	03/08/2016 08:25:20	Enabled	Overwrite events as nec...
Microsoft Office Alerts	1.00 MB/1...	15/11/2016 08:57:04	Enabled	Overwrite events as nec...

1 LAUNCH EVENT VIEWER

If you're running Windows 8 or 10, the simplest way to open Event Viewer is to press Win-X, or right-click the "Start" button and select it from the Quick Access menu. If you're running Windows 7, press Win-R to open the Run dialog box, then type "eventvwr" and press Enter. If prompted by User Account Control, click "Yes" or "Continue."

2 GET A SUMMARY

The main Event Viewer screen appears [**Image A**]. The middle pane should display three sections of information—concentrate on the "Summary of Administrative Events" section at the top, which displays a list of each type of event logged in the past hour, 24 hours, and seven days. Pay particular attention to the "Critical," "Error," and "Warning" sections (but don't panic—yet!).



rview

To view events that have occurred on your computer, select the appropriate source, log or custom view node in the console tree. The Administrative Events custom view contains all the administrative events, regardless of source. An aggregate view of all the logs is shown below.

mary of Administrative Events

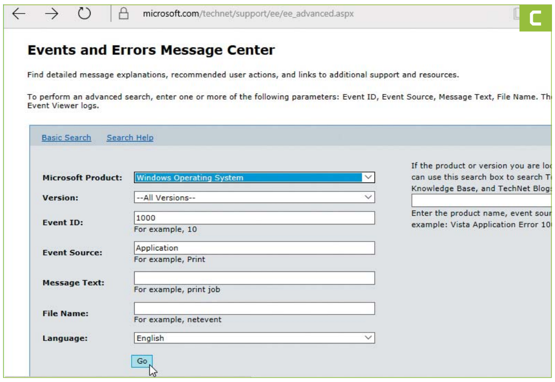
ent Type	Event ID	Source	Log	Last hour	24 hours	7 days
	3	Kernel-EventTr...	Microsoft...	0	0	3
	69	AppModel-Ru...	Microsoft...	0	4	10
	100	Bonjour Service	Application	0	3	0
	513	CAPI2	Application	0	1	
	1000	Application Err...	Application	0	0	

ntly Viewed Nodes

ame	Description	Modified	Created
ustom Views\Summary...		N/A	N/A
ustom Views\Administr...	Critical, Er...	N/A	N/A
indows Logs\Applicati...	N/A	19/11/2016 09:50:51	03/08/2016 08:20:51

Summary

g Name	Size (Curr...	Modified	Enabled	Retention Policy



Events and Errors Message Center

Find detailed message explanations, recommended user actions, and links to additional support and resources.

To perform an advanced search, enter one or more of the following parameters: Event ID, Event Source, Message Text, File Name. Th
Event Viewer logs.

Microsoft Product: Windows Operating System
Version: --All Versions--
Event ID: 1000
For example, 10
Event Source: Application
For example, Print
Message Text:
For example, print job
File Name:
For example, netevent
Language: English

If the product or version you are lo
can use this search box to search T
Knowledge Base, and TechNet Blog

Enter the product name, event sour
example: Vista Application Error 10

3 BROWSE EVENTS

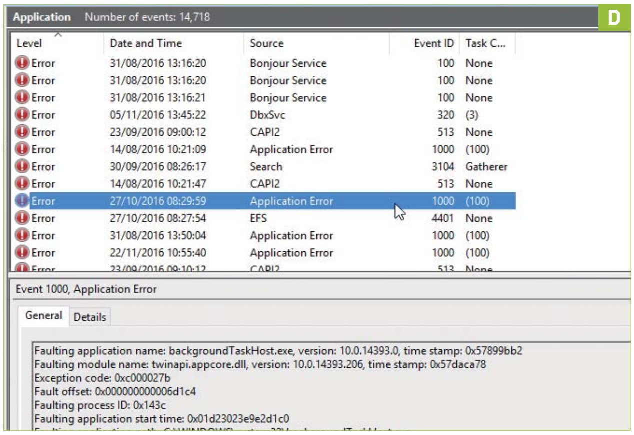
Click "+" next to a section to expand it and view a summary of the events [**Image B**]. Focus on event types that last occurred around the time your problem manifested itself (within the hour, 24-hour, or seven-day ranges). Double-click an event to open its Summary page, then try to identify possible events that correlate to the problem you're investigating.

» Review all instances of the event type, focusing on the time and date each instance occurred. This can help link the event to your problem, but go through all event types under "Critical," "Error," and possibly "Warning" to see whether there are multiple events linked to the problem. Make a note of each one, then read on to discover how to examine them in more depth.

4 GET HELP ONLINE

Make a note of the description—the "Details" tab provides more technical data. You'll notice an "Event Log Online Help" link at the bottom of the "General" tab, which if you click throws up a message—sadly, this doesn't work in Windows 10, but don't worry; instead, open your browser and go to www.microsoft.com/technet/support/ee/ee_advanced.aspx.

» Select "Windows Operating System" for "Microsoft Product," but leave "--All Versions--" selected. Type the Event ID number into the "Event ID" box, and the same



```
Application   Number of events: 14,718

Level    Date and Time         Source              Event ID  Task C...
Error    31/08/2016 13:16:20   Bonjour Service          100  None
Error    31/08/2016 13:16:20   Bonjour Service          100  None
Error    31/08/2016 13:16:21   Bonjour Service          100  None
Error    05/11/2016 13:45:22   DbxSvc                   320  (3)
Error    23/09/2016 09:00:12   CAPI2                    513  None
Error    14/08/2016 10:21:09   Application Error       1000  (100)
Error    30/09/2016 08:26:17   Search                  3104  Gatherer
Error    14/08/2016 10:21:47   CAPI2                    513  None
Error    27/10/2016 08:29:59   Application Error       1000  (100)
Error    27/10/2016 08:27:54   EFS                     4401  None
Error    31/08/2016 13:50:04   Application Error       1000  (100)
Error    22/11/2016 10:55:40   Application Error       1000  (100)

Event 1000, Application Error

General  Details

Faulting application name: backgroundTaskHost.exe, version: 10.0.14393.0, time stamp: 0x57899bb2
Faulting module name: twinapi.appcore.dll, version: 10.0.14393.206, time stamp: 0x57daca78
Exception code: 0xc000027b
Fault offset: 0x000000000006d1c4
Faulting process ID: 0x143c
Faulting application start time: 0x01d23023e9e2d1c0
```

source as listed in Event Viewer into the "Event Source" box (for example, "Application") [**Image C**]. Click "Go" and a list of matching results is shown. Click one to read more about the problem; if there are multiple entries, try them all.

5 BROADEN OR NARROW YOUR SEARCH

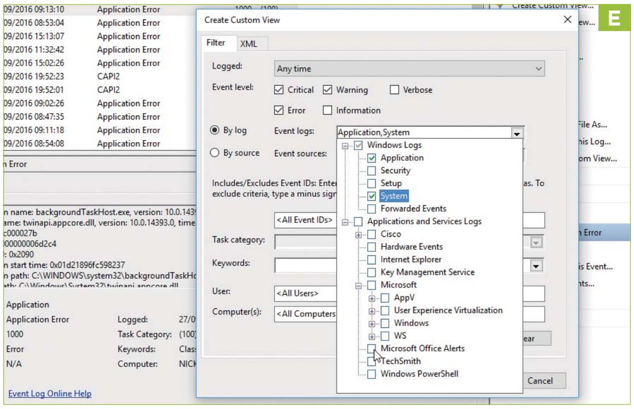
TechNet may return no results (or simply return some generic information about the fault that doesn't really help). Don't give up, though. Make a note of the Event ID, Source, and description under the "General" tab in Event Viewer, then type these into a search engine, and see what results come up. You may find more troubleshooting information via a web page or forum.

›› If too few results are returned, search for fewer words or omit the Source or Event ID from your terms. If too many results come back, narrow it down by including more information. Include specific references to file names in the event log, for example, or provide more general information, such as your version of Windows, hardware device, or software program.

6 BROWSING & FILTERING LOGS

What happens if you can't find the information you're looking for? It's likely the events you need to track are buried away. Manually browse the logs to narrow your search. Expand "Windows Logs" in the left-hand pane, where you'll find logs in categories. Use "Applications" to search for program-related problems [**Image D**], and "System" for Windows and hardware.

›› Logs record all manner of information, much of it irrelevant—at least when troubleshooting a problem. Click the "Filter Current Log" button in the right-hand pane to filter the list a number of different ways: by the time it occurred, the type of event (focus on "Critical," "Error," and "Warning"), event sources, IDs, keywords, or any combination. Click "OK" when done.

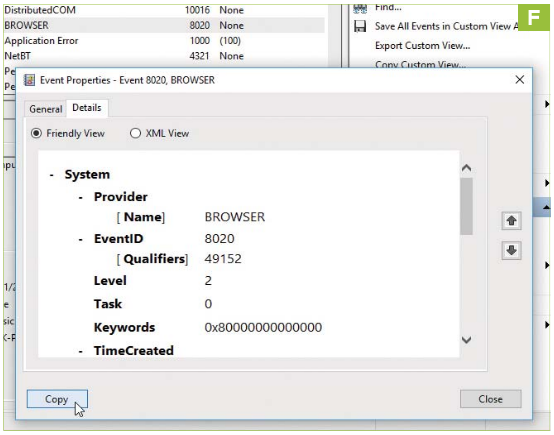


```
Create Custom View

Logged:        Any time
Event level:   ☑ Critical  ☑ Warning  ☐ Verbose
               ☑ Error     ☐ Information
● By log       Event logs: Application,System
○ By source    Event sources:

☑ Windows Logs
    ☑ Application
    ☐ Security
    ☐ Setup
    ☑ System
    ☐ Forwarded Events
☐ Applications and Services Logs
    ☐ Cisco
    ☐ Hardware Events
    ☐ Internet Explorer
    ☐ Key Management Service
    ☐ Microsoft
        ☐ AppV
        ☐ User Experience Virtualization
        ☐ Windows
        ☐ WS
    ☐ Microsoft Office Alerts
    ☐ TechSmith
    ☐ Windows PowerShell

<All Event IDs>
Task category:
Keywords:
User:          <All Users>
Computer(s):   <All Computers
```



```
DistributedCOM     10016  None
BROWSER             8020  None
Application Error   1000  (100)
NetBT               4321  None

Event Properties - Event 8020, BROWSER
● Friendly View   ○ XML View

- System
  - Provider
      [ Name]         BROWSER
  - EventID           8020
      [ Qualifiers]   49152
    Level             2
    Task              0
    Keywords          0x80000000000000
  - TimeCreated
```

7 CREATE AND SAVE YOUR CUSTOM VIEW

If you want to create a filter that provides you with information across multiple logs, or wish to create a filter you can easily access in future, click "Create Custom View" under "Actions." It works in the same way as the filter—to monitor more than one log with your custom view, click the "Event logs" drop-down menu, and check the logs you wish to include [**Image E**].

›› Click "OK," then give your custom view a suitable name, and choose where to save it within the "Custom Views" tree in the left-hand pane. Going forward, you'll be able to access this view at any time directly from here—it's the perfect shortcut for targeted troubleshooting that takes an extended period of time to monitor and act upon.

8 CREATE AND SCHEDULE ALERTS

Change the name to something that will help you recognize it in Task Scheduler, and click "Next" twice. Neither email nor "display a message" options work, so leave "Start a program" selected, and click "Next." Type "msg" into the "Program/script" box, then type "*" followed by your message (for example, "*Error Alert") into "Add Arguments." Click "Next → Finish → OK."

›› Event Viewer also lets you create alerts that are triggered when specific events occur. This can be useful for troubleshooting underlying problems, as you may find a seemingly unrelated event is triggering the error, or get early warning that something nasty is about to happen. Once you've located the event you wish to monitor, right-click it and choose "Attach Task to This Event."

9 REMOVE ALERT

Eventually, you may no longer want that alert popping up (because you've fixed the problem!). To remove it, open Task Scheduler—type "scheduler" into the "Search" box, and click "Task Scheduler" when it appears, or press Win-R, type "control schedtasks," and click "OK." Expand "Task Scheduler Library → Event Viewer Tasks," right-click the alert, and choose "Delete," then "Yes."

10 TROUBLESHOOTING MADE EASIER

Now you've discovered the basics of how Event Viewer works, you can use it to help you track down problems in the future. By examining your system logs using its interface [**Image F**], you should be able to locate the information you need to go out and not just diagnose what's ailing your PC, but also hopefully find a solution to bring it back to good working order, too. ⏻

Improve Your Audio Recordings

YOU'LL NEED THIS

AUDACITY

You can download it from www.audacityteam.org.

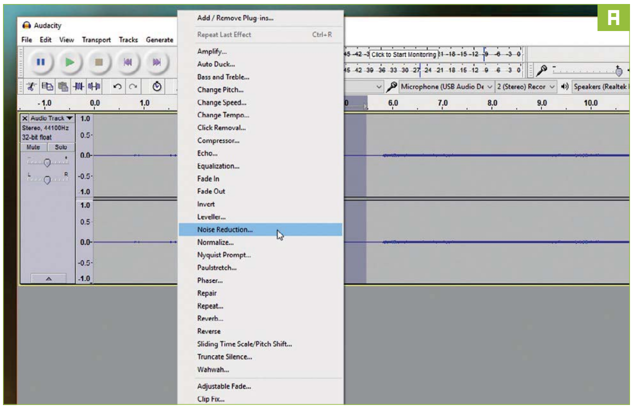
SPITFISH

An Audacity plugin available from http://bit.ly/1i1zfRG.

WITH AN INEXPENSIVE PC MICROPHONE, it's easy to record your own podcasts, music, audio books, or narration for videos. The results can sound great, but by taking a little time to enhance them, you can bring them up to professional standards. Audacity is the perfect software for this; it's powerful, but easy to use, and it's free.

Audacity does an excellent job of cleaning up audio, but there are a few steps you can take to ensure you get the best possible recording quality in the first place. First, make sure the input volume is set correctly by right-clicking the speaker icon in the System Tray, selecting "Recording devices → Microphone → Set up microphone," and following the instructions.

It's also worth using a pop filter to prevent noises being created by the rapid movement of air as you sing or speak. Make your own by following the guide at http://bit.ly/1Y2JwWh. **–CAT ELLIS**

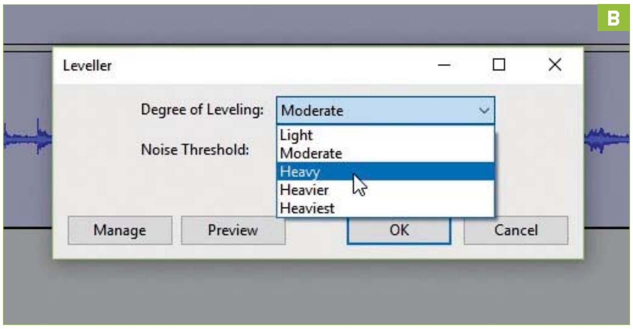

A
Audacity
File Edit View Transport Tracks Generate
Click to Start Monitoring
Microphone (USB Audio De
2 (Stereo) Recor
Speakers (Realtek
Audio Track
Stereo, 44100Hz
32-bit float
Mute Solo
Add / Remove Plug-ins...
Repeat Last Effect Ctrl+R
Amplify...
Auto Duck...
Bass and Treble...
Change Pitch...
Change Speed...
Change Tempo...
Click Removal...
Compressor...
Echo...
Equalization...
Fade In
Fade Out
Invert
Leveller...
Noise Reduction...
Normalize...
Nyquist Prompt...
Paulstretch...
Phaser...
Repair
Repeat...
Reverb...
Reverse
Sliding Time Scale/Pitch Shift...
Truncate Silence...
Wahwah...
Adjustable Fade...
Clip Fix...

1 GET AUDACITY

Visit www.audacityteam.org/download/windows and select the first option: "Audacity 2.1.2 installer." This version contains additional help files, in case you need them later on. The download starts automatically; ignore the links that appear on the following page. Run the software installer, leaving the default settings as they are.

2 MICROPHONE CHECK

Launch Audacity and take a look at the microphone and speaker settings at the top. Make sure these are set correctly, so you aren't recording from your webcam, rather than your USB microphone, for example. If you're not sure which device is selected, click the area marked "Click to start monitoring," and the input from the selected microphone is shown as a green bar.


B
Leveller
Light
Moderate
Heavy
Heavier
Heaviest
Manage
Preview
OK
Cancel

Degree of Leveling: Moderate

Noise Threshold:

3 MAKE YOUR RECORDING

Click the red button or tap Shift-R to start recording. Try to keep a constant distance from the microphone, and don't worry if you trip over a word—pause for a second and say that part again. You can easily cut any mistakes afterward. Once you're done, click the rewind button, then click play to see how it sounds. It's best to use headphones for this.

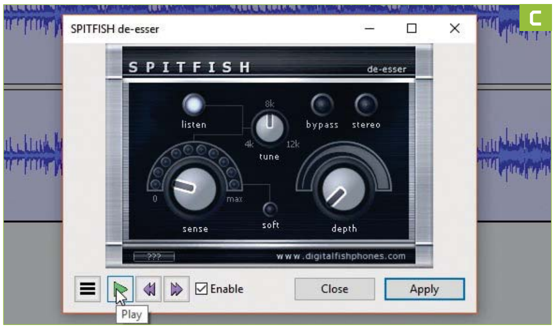
» If you notice background noise in your recording, select a quiet bit of the track by clicking and dragging on a flat part of the blue waveform. Click "Effects → Noise reduction" [Image A], then click "Get noise profile." Tap Ctrl-A to select your recording, click "Effects → Noise reduction" again, then use the sliders and preview to adjust the strength of the effect. When you're happy, click "OK."

4 TRIM TO SIZE

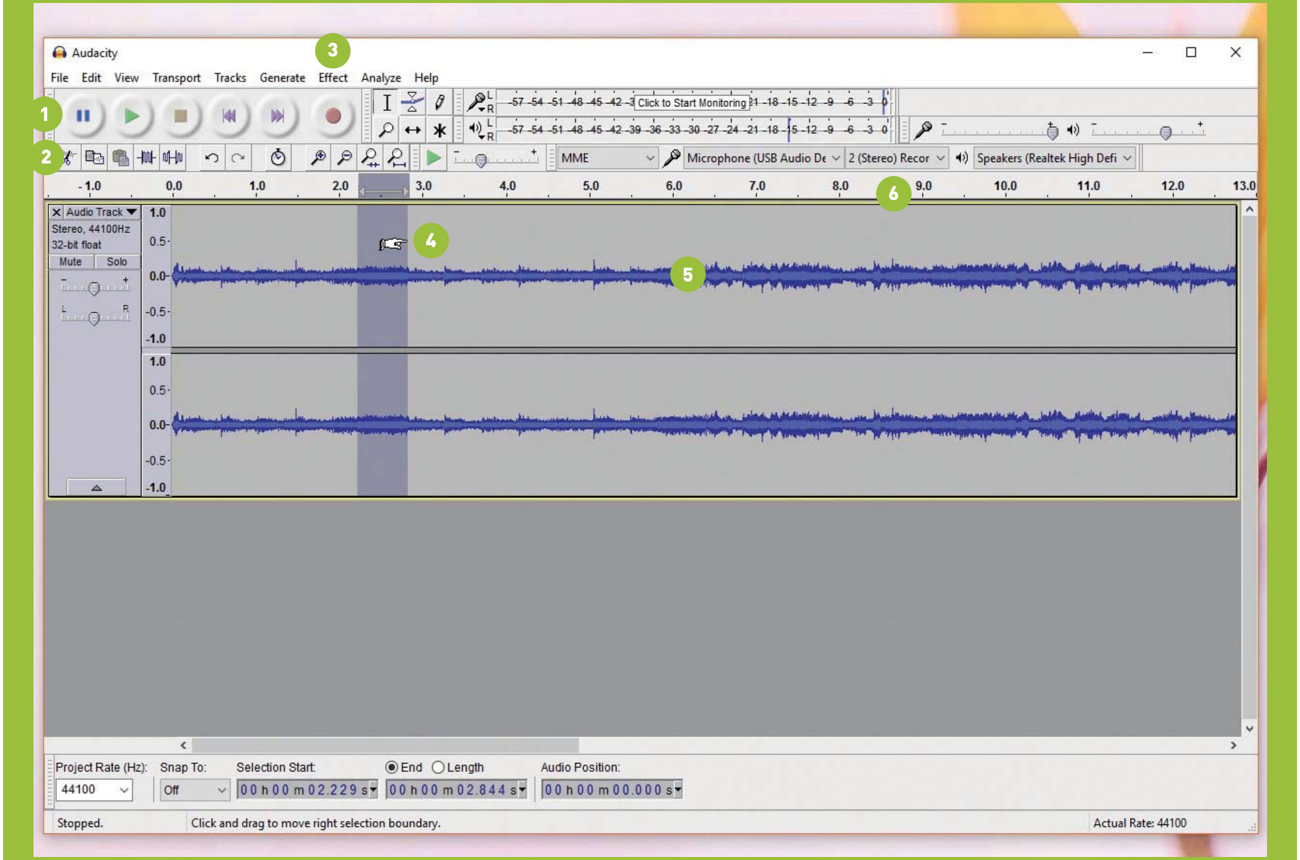
If there's a pause at the start of your recording that you don't want, click and drag to select this part of the waveform, then tap Delete. You can also use this technique to remove any sections of audio where you made a mistake and had to repeat yourself. If you only want to keep a small part of the recording, select that section, then click "Trim Audio" beside the "Paste" button.

5 ADJUST LEVELS

Did you accidentally move away from your microphone while you were recording? If so, some parts of the resulting audio might be louder than others. If that's the case, tap Ctrl-A to select everything, then click "Effects → Leveling," and experiment with the options


C
SPITFISH de-esser
SPITFISH
de-esser
listen
8k
4k
12k
tune
bypass
stereo
0
max
sense
soft
depth
www.digitalfishphones.com
Enable
Close
Apply
Play

ENHANCE YOUR RECORDINGS WITH AUDACITY



Audio Track
Stereo, 44100Hz
32-bit float

Project Rate (Hz): 44100
Snap To: Off
Selection Start: 00 h 00 m 02.229 s
● End ○ Length: 00 h 00 m 02.844 s
Audio Position: 00 h 00 m 00.000 s

Stopped. Click and drag to move right selection boundary. Actual Rate: 44100

1. RECORD AND PLAY
Use these buttons to make and listen to recordings. Hover your mouse over each one to see its corresponding keyboard shortcut and any variations.

2. QUICK CONTROLS
These buttons are used to cut, copy, and paste sections of audio. You can also mute a section ("Silence"), or cut away everything before and after it ("Trim").

3. EFFECTS
In this section, you'll find all of Audacity's tools for refining recordings, plus creative options, such as "Auto Duck," which enables you to speak over a music track by lowering its volume.

4. SELECTION
Click and drag on the waveform to select part of the recording. If you want finer control, tap Ctrl-1 to zoom in.

5. WAVEFORM
A representation of your recording. Audacity records in stereo by default, so there are two tracks (left and right) with identical waveforms.

6. RECORDING AND PLAYBACK
Make sure you have the correct input and output devices selected, to ensure you aren't recording via your webcam instead of your USB microphone, for example.

[**Image B**], checking them with the "Preview" button (the amount of leveling required depends on your own recording).

6 ELIMINATE PROBLEMS

If there's a single particularly loud part of your recording, select it, then tap Ctrl-1 repeatedly to zoom in and isolate the specific waves that are causing it. Make sure you have just these waves selected, then click "Effect → Amplify," and reduce the volume by a few decibels. Use the "Preview" button to check how it sounds before clicking "OK." Tap Ctrl-T to zoom back out.

›› Harsh "s" sounds are a common problem in home audio recordings, but there's a plugin for Audacity called Spitfish that can reduce them. Download it from http://bit.ly/1i1zfRG. Extract the ZIP archive to "Program Files (X86) → Audacity → Plugins." Return to Audacity, click "File → Export Audio," save your audio in WAV format, then restart the program.

7 TONE DOWN HARSH SIBILANCE

Re-open your file, selecting the option to make a copy in case you need to undo your changes. Now select "Effects → Add/remove plugins → SPITFISH → Enable → OK." Tap Ctrl-A, then click "Effect → Spitfish de-esser," and experiment with the settings to tone down the sibilance [**Image C**].

8 EXPORT AND SAVE

Your audio should now sound much better! Click "File → Export Audio," and choose a file type. If you're planning to edit it again later, or use it as a soundtrack for a video, save it in WAV format to keep the quality high. If it's finished, and you're ready to share it, save it in MP3 or WMA format; these provide compression to reduce file size, and are supported by most media players.

BUILD IT

ZAK STOREY, REVIEWS EDITOR

Just How Many Cores?

Is it time to ditch the old gaming adage?

LENGTH OF TIME: **2-3 HOURS** | LEVEL OF DIFFICULTY: **MEDIUM**

THE CONCEPT

SINCE THE LAUNCH of Intel's Core series processors, way back in 2009, there's been one simple rule associated with its mighty lineup of chips: If you're into gaming, to avoid bottlenecks, you're going to want to equip yourself with a Core i5, minimum. Four cores are king—any more, and you're wasting your hard-earned dollar; any fewer, and you're in for a world of frame rate hurt.

However, a lot has changed since 2009. And although the incremental processor performance increases Intel has staggered out of the gates since then have been somewhat lackluster, cumulatively they've provided us consumers with about a 70–80 percent increase in computational performance.

So we got to thinking: As game devs still haven't managed to take advantage of the multiple cores we already have, does that old saying still ring true? Do you still benefit from having a quad-core, high-clocked i5, over a dual-core i3? Or have those IPC improvements lead us into an age when you can get away with a cheaper Pentium for all your 1080p gaming needs? With Kaby Lake finally introducing Hyper-Threading on its Pentium range, allowing for dual-core and four-thread budget offerings, we decided to put it to the test in this quad-optioned mid-range build.

GEFORCE GTX

CORE VARIANCES

DUE TO PAGE LAYOUT RESTRAINTS, we can't put all four variants of our system in the table on the right. However, as it's only the processor that changes during testing, we'll list them here.

Our base system features the Pentium G4600 listed in the table, with two cores, four threads, and a 3.6GHz clock speed (no turbo) for a total of $1,236. The next uses Intel's Core i3-7300, with two cores and four threads, still sans turbo, packing an impressive 4.0GHz, taking the total to $1,278. The next step up is substantial: the Core i5-7600K, a four-cored, four-threaded turbo behemoth, capable of hitting 4.2GHz at stock, and bumping the price up to $1,361. And, finally, the Core i7-7700K. Four cores, eight threads, and a 4.4GHz maximum turbo brings the total skyrocketing up to $1,438—a difference of $202 from Pentium to Core i7.

We decided to take advantage of Corsair's Carbide 270R. This budget chassis checks all the boxes for our mid-range build. It's accessible, comes with just enough hard drive support to keep us happy, and provides a clean-looking aesthetic inside and out. Cooling support is strong, and the addition of a clean PSU cover made it a no-brainer. For GPU, we chose Nvidia's GTX 1060 6GB. We could have gone with an AMD RX 480 8GB, but the GTX 1060 provides more frames per dollar than the RX 480, so it wasn't a tough call to make. On top of that, two SSD hard drives and 16GB of DDR4 pull this beauty right into 2017 with a bang.

INGREDIENTS

PART		STREET PRICE
Case	Corsair Carbide 270R	**$70**
Motherboard	Gigabyte Z270X-Ultra Gaming	**$165**
CPU	Intel Pentium G4600	**$87**
Memory	16GB (2x 8GB) Crucial Tactical @ 2,666MT/s	**$102**
GPU	Nvidia GeForce GTX 1060 6GB	**$245**
PSU	Corsair RM650X	**$109**
Storage 1	Sandisk Ultra II 240GB SSD	**$80**
Storage 2	Crucial MX300 1TB SSD	**$260**
Cooling	Cooler Master MasterLiquid Pro 240 & 1x Corsair ML120 Pro Red	**$118**
Total		**$1,236**

1

COOLING ISSUES

COOLER MASTER'S LATEST 240MM AIO was a headache, as it deviates from the traditional Asetek mounting design. With most coolers, you secure the backplate to the motherboard using double-ended screws of varying sizes, depending on whether you're attaching it to a 2011 board, a 1150/51 board, or an AMD offering. Then you place the CPU block on the four screws, and secure it with four thumb screws. With the MasterLiquid Pro, Cooler Master has removed the screw between the board and the backplate, so you have to position the backplate through the board, with long pre-attached screws. Then, while holding the backplate in place, you position the block on the screws. Finally, while somehow holding it so it doesn't move, you use the thumb screws to secure it. Pro tip? Find a buddy or, as we did, literally use your head to hold the block in place.

GIGABYTE
COOLER MASTER

2

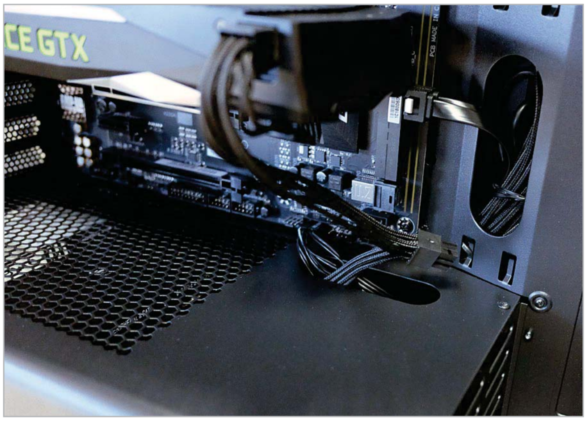
DUST CONUNDRUMS

ONE OF THE FEW COMPLAINTS we have about Corsair's 270R stems from the uppermost fan mounts—primarily that they lack any form of dust cover. Being an awkward size and not supporting 360mm radiators either, regardless of its dimensions, makes things even more frustrating when you're on the hunt for a dust filter. Your best bet, if building in this particular chassis, would be to use two 120mm fans to blow air out of the top of the chassis. This should at least prevent too much dust entering your system while it's running, although it will need some loving maintenance to keep it truly clean in the long term.

3

GPU CABLE ISSUES

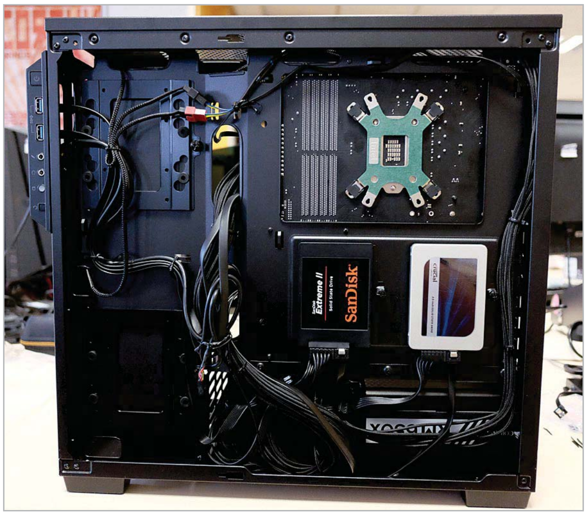
OH, THE PROBLEMS of using bits and pieces from our storage cupboard: We wanted to use a custom cable kit in conjunction with our Corsair RM650X power supply, just to spruce it up a bit, but our only kit had already been cannibalized for our editor's Dream PC from two issues ago, so there were only a few bits remaining. A single CPU power, one spare ATX power (specifically designed for the RMX, as the HXi has different 24-pin requirements), and a single GPU cable. The GPU cable in question, however, was a dual connector, so we were left with one part hanging out just below the GPU, which we couldn't hide around the back, or behind the cable cut-out situated below.



4

CABLE MANAGEMENT SORTED

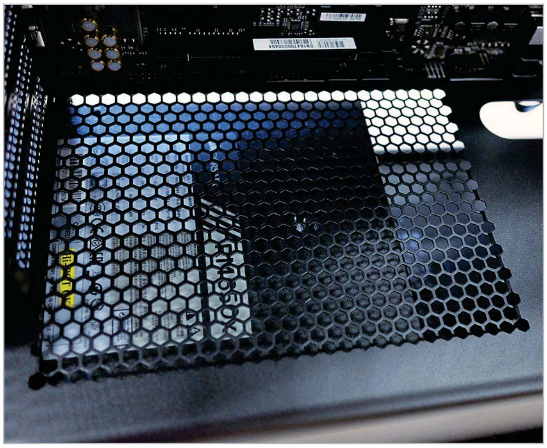
WE WENT ALL-OUT with this little build to get the cable management just right. Using a plethora of cable ties, we secured what we could to the back of the chassis, to make sure airflow wasn't restricted, and to ensure that the rear side panel was easier to replace—and, to be honest, to keep everything looking a little tidier. Take your time on this bit: Figure out which cables go under what, and where you can hide stuff, without it being too much of a major issue.



5

PSU COVER

ALTHOUGH CORSAIR still doesn't have quite as clean and beautiful a PSU cover as a lot of its competitors, it's damn good to see one included here. Three-quarter sized, it provides plenty of ventilation for multiple orientations of power supply, and easily lets us hide the vast majority of our excess cables below. One thing that still haunts us from our water-cooling days, however, is fan orientation. We always advise that you install your power supply with the fan facing down wherever possible, because a leak from the AIO or a GPU block, for instance, is likely to kill it.

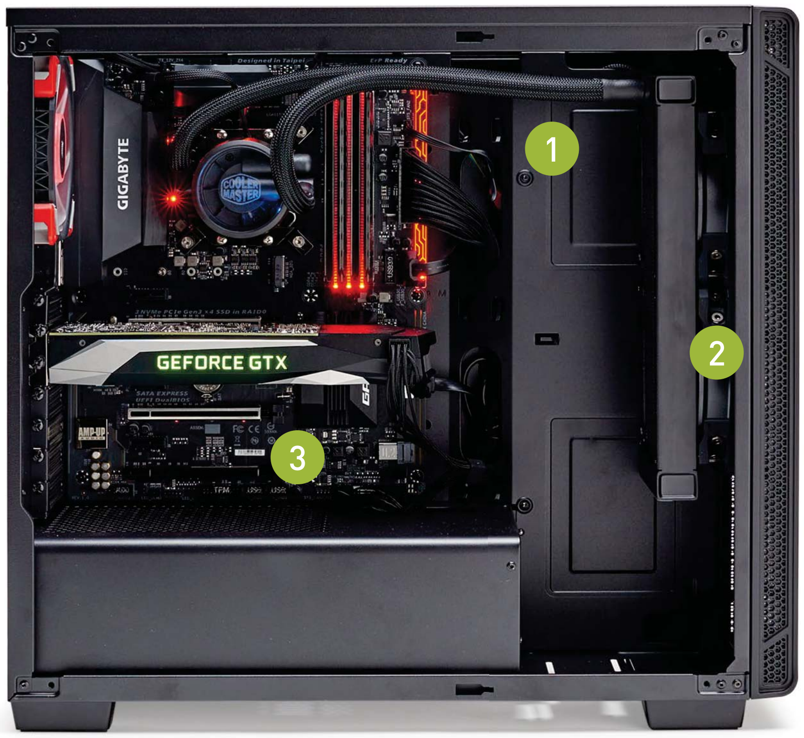


6

LED CORNUCOPIA

COLOR CO-ORDINATION wasn't at the front of our minds when we built this machine, but we're actually quite impressed with how it turned out. We threw in a Corsair ML120 Pro in red in the back to spice it up a little, and help the air shift around efficiently inside, but the combination of the red motherboard with the blue cooler and green GPU actually kinda works, especially considering the price. The Z270X-Ultra Gaming does come with additional strips if you do want to change out to another color—but, hooey, that's a lot of effort for not a lot of gain.

GIGABYTE
GEFORCE GTX



1 Although you can't see it from the front, it's entirely possible to mount two 3.5-inch hard drives in the back. Strip out the crazy 1TB SSD here and replace it with an HDD instead, and you could easily save $200.

2 We had issues with the fans running in push configuration in this chassis. Cooler Master's fan design allows the fan blade unit to move forward, eventually scraping against the chassis at higher speeds. We added rubber spacers to stop this from happening.

3 Gigabyte's Z270X-Ultra offers extra spacing between front panel headers, making it easy to identify where to install your power cables. Additionally, we never install the HD audio pass-through, because quality generally tends to be far worse than via the rear I/O.

THE END OF THE ROAD FOR THE CORE i5?

WELL, THERE YOU HAVE IT FOLKS: a double whammy mini feature buried within Build It. So, is this the end of the road for Intel's Core i5 series processor? Probably not. Legacies are always difficult to quash, and just as AMD's Ryzen has one hell of a stigma to overcome in the mind of the average PC enthusiast, so does the concept of the Core i5 not being the king of gaming.

Take a glance at the Internet, and you'll see dozens of commentators purporting that the Core i5 is the way to go, and that even going up to the Core i7 isn't worth the cash, because you only gain 10 percent performance in games. The reality, on the other hand, is very different. Across the board, from one of Intel's lowest $80 chips all the way up to its mainstream rendering powerhouse at $350, there's absolutely no difference in game. It seems those IPC improvements have been making a difference to the ecosystem after all—just not in the way we might think.

Building this particular system was actually considerably frustrating—mostly due to the cooler being so incredibly annoying to install. The backplate, coupled with the fans scraping the front of the chassis, and the pipes being far too resistant to movement, really gave us pause for thought as to whether this was the right cooler for us. We even had to unplug and reinstall the PWM pump fan header at first, because it refused to pump water around the system, forcing our Intel Core i7, that we tested first, to install Windows 10 on to the SSD at 99–100 C, at a paltry 200MHz. Although it was certainly impressive to witness, it was also excruciatingly frustrating.

Cooler problems aside, it turned out to be a pretty clean-looking build. Keeping all the storage around the back of the motherboard tray actually makes a world of difference. And, although the PSU cover is only a 75 percent case fit, it does leave plenty of room for radiators and cooling up front, and it grows on you after a while. Is there anything we would change? Well, if this were genuinely a build for purchase, not designed for that wide range of processor testing, we would probably drop the 1TB SSD in favor of an HDD, potentially go down to a B250 motherboard to save a bit of cash, use a lower specced PSU, and potentially even 8GB of DDR4, depending on budget constraints. That would bring this particular build down to around $630, including shipping. ⏻

BENCHMARKS

	INTEL PENTIUM G4600	INTEL CORE i3-7300	INTEL CORE i5-7600K	INTEL CORE i7-7700K
Cinebench R15 Single/Multi (Index)	148/388	172/437	182/699	**191/960**
CrystalDisk QD32 Sequential Read/Write (MB/s)	538/514	535/510	**541/516**	537/515
3DMark Fire Strike (Index)	9,179	9,542	10,606	**11,184**
Deus Ex Mankind Divided (Avg fps)	**25**	**25**	**25**	**25**
Rise of the Tomb Raider (Avg fps)	**39**	**39**	38	**39**
Far Cry Primal (Avg fps)	66	**67**	**67**	**67**
Attila: Total War (Avg fps)	37	38	**39**	**39**
Steam VR Performance Test (Index 0–10)	8.2	8.2	**8.3**	8.0

Best scores are in bold. All games were tested at the highest possible 1080p settings, bar *Deus Ex* (tested at Very High graphical profile).

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REVIEWS

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DIGITAL STORM VELOX PAGE 78

The Velox nearly matches Digital Storm's massive Aventum 3—for several thousand dollars less.

Digital Storm Velox

White-hot performance

ABOUT SIX MONTHS AGO, we put the giant blue box that was Digital Storm's Aventum 3 desktop to the test. It was a beastly gaming machine, but heavy as hell, and just as expensive. We're thinking of the Velox as the Aventum's little brother, and for a little more than half the cost, it performs nearly as well as its elder sibling.

A big part of the Aventum's $8,500 price tag was due to its Hyper-Threaded Core i7-6950X, which checks in at $1,700. The Velox makes up for skipping on the enthusiast-class CPU route thanks to Intel's new Kaby Lake processors. Our unit was outfitted with a Core i7-7700K, overclocked to 4.9GHz, one of the highest desktop core clocks we've seen on a prebuilt system. While it doesn't quite keep up with the 6950X in Cinebench R15 or x264, which really take advantage of Hyper-Threading, the 7700K was hot on the Aventum's heels in PCMark 8 Creative, with a score of 9,404.

To complement the Kaby Lake CPU, the Velox features an Asus Maximus IX Hero Z270 motherboard. Slotted in there is 32GB of DDR4-2666 RAM, and a 512GB Samsung 960 Pro SSD, connected via NVMe. For additional storage, the 960 Pro is backed up by a 3TB Toshiba HDD. A Corsair H115i liquid cooler keeps CPU temperatures down, while the case is outfitted with Thermaltake Riing fans for everything else. Finally, graphics are handled by a pair of GeForce GTX 1080s, outfitted with EVGA's ACX 3.0 cooling solution.

Size-wise, the Velox's all-metal chassis is exactly what we like to see from a top-end gaming desktop: big (22 x 19.5 x 10 inches) but not excessive, with a large side panel through which to see its glorious innards. Even better, the side panels attach via metal pegs fitted into rubber sockets, in lieu of thumb screws. The panels attach and detach with a snap, making it exceptionally easy to access the mobo and hard drive cages. There's a lot of empty space, giving things a minimalist aesthetic, but it also means the case can only accommodate one additional HDD in the main cage, and two SSDs behind the motherboard. That's not a lot of expandability for this level of system, but it should be enough for most users. Either way, Digital Storm uses custom-color sleeved PSU extension cables and cable combs to keep things tidy, combined with remote-controlled LEDs, making it all very pretty to look at.

BEAUTY AND BEAST

Aesthetics are one thing, but they don't count for much without performance to match. Luckily, the Velox plays games as good as it looks. The pair of EVGA GeForce GTX 1080s handled all the difficult tasks we threw at them with aplomb, but sometimes faltered at the seemingly easier tasks: rendering games at the paltry resolution of 1080p. We measured an average of 113fps across *Rise of the Tomb Raider's* three-part benchmark in 1080p at max settings, while *The Division* registered 150fps at the same settings. *Far Cry Primal,* on the other hand, pulled in only 82fps at 1080p—a low score for what should be an easy task.

This can largely be accounted for by SLI not playing nice with lower resolutions, and all of our tests fared much better at higher resolutions. *Far Cry Primal,* for instance, actually scored the same in 4K as it did in 1080p, with its best frame rate showing up in 1440p (95fps). *RotTR* and *The Division* scored 104 and 114fps in 1440p; 76 and 70fps in 4K, respectively, all at max settings. This is thoroughly impressive, because even big brother Aventum sometimes struggled to keep 4K frame rates consistently above 60fps.

Even at half the Aventum's price, the Velox is still an expensive machine. Like most custom-built systems, you could probably shave $1,000 or more off the price by building it yourself, but Digital Storm brings a lot to the table here. Between build quality and all the benefits of having a warranty and customer service, the Velox delivers on the promise of a top-end gaming machine. **–BO MOORE**

VERDICT 9 KICK ASS!

Digital Storm Velox

+ BROTHERLY LOVE Beautiful build quality; outstanding high-resolution gaming performance; way less expensive than the Aventum 3.

– ESTRANGED FAMILY Few empty drive bays; poor 1080p performance.

$4,737, www.digitalstorm.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 (Index)	987	1,047 (6%)
TechARP's x264 (fps)	21.93	23.59 (8%)
PCMark 8 Creative (Index)	7,675	9,404 (23%)
CrystalDiskMark 4K Read (MB/s)	54.85	58.79 (7%)
CrystalDiskMark 4K Write (MB/s)	171	215.3 (26%)
Far Cry Primal (fps)	76	82 (8%)
The Division (fps)	78	152 (95%)
Rise of the Tomb Raider (fps)	41	113 (176%)
3DMark Fire Strike (Index)	15,026	25,974 (73%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point has a Core i7-6700K overclocked to 4.6GHz, an XFX Radeon R9 Fury X, 32GB of Kingston HyperX Savage DDR4-2400, and a 256GB Samsung 950 Pro, mounted on an Asus Z170i Pro Gaming mobo.

SPECIFICATIONS

Processor	Intel Core i7-7700K @ 4.9GHz
Graphics	2x SLI EVGA ACX 3.0 GeForce GTX 1080 8GB
RAM	32GB Digital Storm Performance Series DDR4-2666
Motherboard	Asus Maximus IX Hero (Z270)
Primary Storage	512GB Samsung 960 Pro M.2 NVMe SSD
Additional Storage	3TB Toshiba
Cooling Solution	Corsair H115i 280mm liquid CPU cooler, Thermaltake Riing case fans
PSU	850W EVGA SuperNOVA
Case	Digital Storm Velox Chassis
Warranty	Lifetime Expert Care with three-year limited warranty (three-year labor & one-year direct part replacement)

GIGABYTE
GA-Z270X-Ultra Gaming
3 NVMe PCIe Gen3 ×4 SSD in RAID0
Intel GbE LAN
SATA EXPRESS
UEFI DualBIOS
AMP-UP AUDIO
ErP Ready
Socket 1151
DDR4
nVIDIA SLI
AMD CROSSFIRE
GIGABYTE GAMING

RGB mobos? We still don't get it.

Gigabyte Z270X-Ultra Gaming

A badass budget-busting bombproof board

WITH THE VAST MAJORITY of boards, as far as average users are concerned, providing little beyond greater connectivity and expandability, forking out the cash for flashier mobos often makes little to no sense. Performance differentials are almost non-existent, and taking a GTX 1080 and a Core i7-7700 from a $70 B250 mobo all the way up to the $300 kings of Z270 will likely provide practically no difference beyond increased connectivity, better looks, and a flashier UEFI BIOS. Unless you're on the liquid-nitrogen cooling train, with a full-fledged arsenal of Core i7s beside you, you're unlikely to see much difference, as the PC ecosphere tends to lend itself more to silicon limits within the processors themselves than anything the motherboards can muster.

So, Gigabyte's Z270X-Ultra Gaming impressed us from the get-go. On the outside, it certainly looks like a high-end choice. A quick glance, and you'll see brushed black aluminum heatsinks, the now ever-present RGB lighting, a rear I/O shield, and a cornucopia of connectivity, including a single M.2 PCIe x4 slot, a U.2 connector, a bank of four SATA ports (including SATA Express), two separate SATA 6Gb/s ports, and two internal USB 3.0 headers as well. No doubt a premium offering, then? Well, perhaps not—the Z270X-Ultra Gaming is currently available for a meager $165. That's $30 less than the ITX board we picked up from MSI this issue, and half the price of MSI's overclocking pro Z270 XPower Gaming Titanium we reviewed the issue before.

Does it show? Sort of, but not in the places you might expect. Performance across the board was actually pretty impressive. At stock, it easily outpaced every single motherboard we've tested to date, scoring a pleasing 21.16fps in X265, and a staggering 995 points consistently in Cinebench R15. Memory latency was also top-notch, coming in at an incredible 54.0ns.

However, it's not all plain sailing, and it's only when you start looking at how the board handles voltage, in particular, that you realize just where it's coming unstuck. By default, the Ultra Gaming auto-fixes CPU Vcore voltage between 1.3 and 1.35V—at most, 0.1V higher than Intel's prescribed settings, and more than 0.05V higher than most other competitors. Not only does this improve general stability, but it also allows Gigabyte to optimize CPU performance across the board at stock. The downside, however, is that it draws notably more power from the wall under load, with our figures showing 156W maximum, with only the XPower coming close out of the five boards we've now tested, at 131W. And, alas, that isn't the end of the Ultra's voltage problems. During our overclocking spree, and similar to all the boards previously tested, it still managed to achieve the 5GHz silicon limit, but at a noticeably higher voltage than the others, at 1.33V, with only the Z270i Gaming Pro Carbon coming close, at 1.32V. Undervolting also failed to impress, with the Gigabyte again being the highest, at 1.12V at stock.

Overclocking is only a small part of the package, of course, and although tweaking voltages can reduce overall processor temperatures, it'll probably be an afterthought for the majority of people. Voltages aside, the plethora of connectivity options, fantastic aesthetics, strong stock performance, and price make the Z270X-Ultra Gaming phenomenally good value for money. And similar to the offerings Gigabyte mustered last generation, we can't see many, if any, mobo manufacturers ousting Gigabyte from the top spot of best bang for buck just yet. **–ZAK STOREY**

BENCHMARKS

	Gigabtye Z270X-Ultra Gaming	Asus Maximus IX Hero
X265 Benchmark (fps)	**21.16**	21.02
Cinebench R15 (Index)	**995**	977
FryRender (m:s)	**3:32**	3:36
AIDA64 Memory Latency (ns)	**54.0**	59.5
CrystalDisk Sequential Read/Write (MB/s)	3,073/**1,562**	**3,131**/1,546
Power Draw Idle/Peak (W)	**42**/156	43/**126**
Far Cry Primal @ 4K (Average fps)	**43**	**43**
3DMark Fire Strike Extreme (Index)	**9,532**	9,442
Maximum Overclock Achieved (GHz)	5.0	**5.1**
Lowest Undervolt @ Stock (V)	1.12	**1.07**
Lowest Voltage @ 5GHz (V)	1.33	**1.28**

Best scores in bold. Our test bench consists of an Intel Core i7-7700K (separate chip to our Asus Maximus IX Hero review), 16GB of Corsair Dominator Platinum @ 2,400, GeForce GTX 1080, and 250GB Samsung 960 Evo PCIe SSD.

VERDICT

9

Gigabyte Z270X-Ultra Gaming

+ GIGATON HAMMER Vast feature set; great aesthetics; RGB lighting if you want it; strong stock performance; impressive price.

− GIGGLEBYTE Voltages slightly high; potentially higher temps because of that.

$165, www.gigabyte.com

SPECIFICATIONS

Chipset/Socket	Z270/LGA 1151
Form Factor	ATX
Memory Support	64GB DDR4 @ 3,866MT/s
M.2/U.2 Support	1x M.2 PCIe x4, 1x U.2 PCIe x4
SATA Support	6x SATA 6Gb/s, 2x SATA Express
Max PCIe Support	3x PCIe x16 (x16, x8, x4)
Rear I/O	5x USB 3.1, 2x USB 2.0, 1x USB 3.1 Type C, 1x Intel Gigabit Ethernet, 1x PS/2 combi port, 1x DVI-D, 1x HDMI, 1x S/PDIF out, 5.1 audio

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MSI Z270i Gaming Pro Carbon AC

Z270 ITX offering

IN THE EARLY NOUGHTIES, an interesting concept arose from our fervent pursuit of more powerful technology: As transistor size shrank, efficiency per watt increased, and die size fell, manufacturers aggressively pushed for smaller and smaller devices. The ITX form factor was developed in 2001 by VIA Technologies as a way of shrinking desktop computers to a more manageable size, and it has since become a staple for enthusiasts looking to build a tiny desk-sitting powerhouse.

MSI's Z270i Gaming Pro Carbon is the first in the latest line of Kaby Lake boards we've seen that deals with ITX. And we'll be honest: Although the on-board support is as good as, if not better than, it has ever been, the rear I/O gives us pause. This isn't limited to MSI, though—Gigabyte, Asus, and ASRock have all stripped down the rear I/O of their ITX offerings, and put about 25 percent less stuff on it. Because, you know, ITX system users have fewer peripherals, or something. Yeah, we don't get that logic either. Anyway, let's compare the Z97i Gaming AC against the Z170i Gaming Pro and the Z270i Gaming Pro Carbon. The Z97i has four USB 3.0 and four USB 2.0 connections, giving a total of eight. The Z170i has four USB 3.1 and two USB 2.0, for a total of six. And the Z270i has three USB 3.1 and two USB 2.0—a total of just five. It sounds like a petty complaint, but look at the plethora of peripherals that connect via USB, and it's easy to see how quickly those connections can be taken up. A mouse, a dual-port keyboard with a pass-through, a webcam, a USB headset—that's five ports taken up immediately. Got a wireless dongle? Too bad. A wireless controller? Not any more.

PIN POINTS

USB woes aside, MSI's Z270i Gaming Pro Carbon is a solid board. It's nice to see the ITX layout get finalized, with 24-pin and 8-pin power getting concrete placement, and SATA and USB being more accessible than before. The reinforced DDR and PCIe ports, although laughable, do give you a little more assurance—the weight of a GPU isn't going to shatter them. And the M.2 PCIe x4 slot on the back keeps us happy when it comes to super-fast storage.

Performance was consistent, as always, with little variance between many of the benchmarks. Memory latency took a hit, and our X265 benchmark was the worst of the boards we've tested so far, but that was made up for by the lower power draws.

Overclocking was a little under par—our lowest undervolt from stock was 1.1V, the highest of the boards we've tested, and we managed 5GHz at 1.32V, compared to the 1.3V of last issue's more overclocking-oriented XPower Titanium. It is a solid offering—it's just a shame that the rear I/O is shrinking at such a rate. **–ZAK STOREY**

VERDICT
7

MSI Z270i Gaming Pro Carbon AC

+ **ANACONDA** Solid performance; M.2 port on rear.

− **EARTHWORM** Limited overclocking; disappointing rear I/O.

$180, www.msi.com

BENCHMARKS

	MSI Z270i Gaming Pro Carbon	MSI Z270 XPower Gaming Titanium
X265 Benchmark (fps)	20.57	**21.15**
Cinebench R15 (Index)	982	**984**
FryRender (m:s)	**3:31**	3:36
AIDA64 Memory Latency (ns)	66.3	**59.7**
CrystalDisk Sequential Read/Write (MB/s)	3,160	**3,249**
Power Draw Idle/Peak (W)	**41/117**	45/131
Far Cry Primal @ 4K (Avg fps)	**43**	42
3DMark Fire Strike Extreme (Index)	9,508	**9,595**
Maximum Overclock Achieved (GHz)	**5.0**	**5.0**
Lowest Undervolt @ Stock (V)	1.1	**1.09**
Lowest Voltage @ 5GHz (V)	1.32	**1.3**

Best scores are in bold. Our test bench consists of an Intel Core i7-7700K, 16GB of Corsair Dominator Platinum @ 2400, a GeForce GTX 1080, and a 250GB Samsung 960 Evo PCIe SSD.

SPECIFICATIONS

Chipset/Socket	Z270/LGA 1151
Form Factor	Mini-ITX
Memory Support	32GB @ 3,800MT/s
M.2/U.2 Support	1x M.2 PCIe x4
SATA Support	4x SATA 6Gb/s
Max PCIe Support	1x PCIe 3.0 x16
Rear I/O	Wireless ac, 2x USB 2.0, 3x USB 3.1 Type A, 1x USB 3.1 Type C, Intel Gigabit Ethernet, 5.1 audio, SPDIF out, HDMI, DisplayPort

Crucial MX300 2TB

The cheapest 2TB SSD in town

crucial
by Micron
2.5-inch SOLID STATE DRIVE

SOLID-STATE STORAGE is one of the wonders of the modern world. Thinking about it, we're reminded of the immortal words of Arthur C Clarke, the great science fiction writer. He reckoned that any sufficiently advanced technology seems like magic.

Go back 100 years, and what would anyone make of, for instance, a 256GB MicroSD card? The notion something so tiny could store hundreds of thousands of books would surely seem like witchcraft. Nowadays, it's pretty impressive that you can bag a 128GB USB stick for under $25.

Despite that, SSDs aren't yet the default option for mass storage. That will happen eventually. But not yet, not even thanks to Crucial's 2TB MX300. It's about as close as you'll get to a really big SSD aimed at a mainstream audience. At $549, however, it's getting on for 10 times the price of the cheapest 2TB magnetic hard drive.

Of course, the MX300 still majors on capacity rather than performance. That's because it's a SATA drive, rather than a PCI Express model, which brings limitations in terms of the peak bandwidth on the SATA interface and the inefficiencies of the AHCI protocol it uses. The latter never being designed with solid-state storage in mind.

Thus, we're talking peak claimed performance around 500MB/s for reads and writes, and IOPs a fair bit below 100,000. The 2TB MX300, incidentally, has the same claimed performance for sequential throughput and IOPs as the 1TB, 750GB, and 525GB MX300 models. Only the entry-level 275GB model differs with slightly lower performance. It also shares the familiar Marvell 88SS1074 controller with the rest of the MX300 family.

Similarly, this 2TB model uses the same 384Gb TLC 3D flash memory dies as previous MX300s. It's that unusual capacity per die that leads to the MX300 range having odd sizes, with this drive serving up 2,050GB. The MX300 range also has a dynamic write acceleration mode that switches a portion of the memory to SLC mode for increased performance. For the 2TB model, the amount of memory that can be switched to SLC mode is increased.

The MX300 also comes with Crucial's SSD management software, which enables you to tweak settings and performance. Among other features, you can update the firmware, monitor the health of the NAND chips, and toggle the Momentum Cache feature, which uses system memory to buffer random writes.

If all that reads like a feature list without much real-world analysis, the truth is that the MX300's real-world performance isn't all that interesting. SATA SSDs such as this are a fairly mature technology, and the limitations we mentioned mean there's zero chance of this drive setting any new records. What you want is a reliable drive with no performance nasties. That's what the 2TB MX300 largely delivers.

In our synthetic performance tests, it delivers pretty much exactly what you'd expect, with peak performance around 500MB/s, and 4K results in the mid-20MB/s area for reads, and 120–140MB/s for writes, depending on the benchmark app in question. It's a similar story of generic SATA drive performance in our real-world compression and copy benchmarks. All of which means the MX300 ultimately trades on price, which is handy, because it's comfortably the cheapest 2TB SSD you can currently buy. **–JEREMY LAIRD**

VERDICT 8

Crucial MX300 2TB

+ **BIG LEAGUE** Mass-storage class capacity; very competitive pricing; no performance nasties.

− **ALTERNATIVE FACTS** Mega money compared to a magnetic drive; PCI Express drives are far faster.

$549, www.crucial.com

BENCHMARKS

	Crucial MX300 2TB	OCZ Trion 100 960GB	Samsung 850 Pro 2TB
AS SSD Incompressible Sequential Read/Write (MB/s)	469/480	**513**/436	**513/499**
AS SSD 4K Random Read/Write (MB/s)	24/119	31/92	**41/126**
ATTO Sequential Read/Write (MB/s)	526/**535**	**564**/517	404/427
5GB Zip (Seconds)	**185**	194	194
30GB Internal Copy (Seconds)	197	263	**160**

Best scores are in bold. Our test bench consists of an Intel Core i7-7700K, an Asus ROG Maximus IX Hero, 16GB Corsair Dominator Platinum 2,400MT/s, and an Nvidia GeForce GTX 1080.

SPECIFICATIONS

Capacity	2,050GB
Memory Type	TLC 3D NAND
Controller	Marvell 88SS1074
Form Factor	2.5-inch
Interface	SATA
Read Performance	530MB/s
Write Performance	510MB/s
4K Reads	92,000 IOPs
4K Writes	83,000 IOPs
Warranty	Three years

Intel Pentium G4600

Hip, hip, hooray for Hyper-Threading

INTEL® PENTIUM®
G4600
SR35F 3.60GHZ
L647G72 e4

IT'S VERY LIKELY end of days for Intel's CPU strategy as we know it. We don't mean that in an apocalyptic sense. Intel isn't about to suffer an existential calamity. But AMD's Ryzen processor is coming, and we're confident it's going to shake things up.

That's the context into which Intel's Pentium G4600 arrives. Based on the latest Kaby Lake microarchitecture, it's very much a child of the last five years or so, when Intel ruled on the high seas, across the land, and up in the air. Within that narrative, the fact that Intel has bequeathed the G4600, plus two other new Kaby Lake Pentiums, with Hyper-Threading capability constitutes news.

Hyper-Threading is the ability for each CPU core to process two software threads in parallel. And it's been baked into every Intel Core processor since Nehalem in 2008. Actually, it's rumored that it was also in the Core 2 Duo, just not enabled. And, of course, it was first seen in the Pentium 4 Netburst chip way, way back in 2000.

The point is that it's always in any desktop CPU model you buy from Intel; it's just enabled or disabled to help cook up a few different chip models. It's the sort of ruse you can get away with when you have little to no competition—a situation that prevails today, but isn't going to last.

Anyway, the Pentium G4600 slots in at $82, and offers up two Hyper-Threading enabled 3.6GHz cores, supported by 3MB of cache memory. And that's pretty much it for the CPU side of things. There's no turbo mode, and the CPU multiplier is locked, so overclocking is essentially a non-starter.

Like all mainstream desktop CPUs, the processor cores are only half the story—literally, as integrated graphics make up almost half of the G4600's 14nm CPU die. In this case, it's an Intel HD Graphics 630 GPU, at the top end of the smaller of the two graphics cores Intel is sticking in its Kaby Lake chips. It has 24 execution units to the 48 of the Iris Plus cores. So, even by integrated standards, it's nothing special. But for $82, you aren't getting special.

What you are getting is very good single-threaded performance. The G4600 cranks out 151 points in Cinebench R15 in single-threaded mode. The Core i7-7700K manages 182. Put another way, if all you were interested in was single-threaded performance, and overclocking wasn't in your vocabulary, there'd be little reason to spend more than 82 bucks on a G4600.

Flick the multi-threading switch, on the other hand, and those numbers jump to 385 and 970. The 7700K is only a quad-core chip, of course. The 10-core Core i7-6950X monster will spew out about 1,750 points in Cinebench. Then again, it costs about 15 times as much. Arguably, then, what matters is that for general-purpose computing, the G4600 gets the job done. It feels perfectly zippy for web browsing, playing back HD video content, and most anything else you're likely to do day to day.

It even turns in decent numbers in games, showing that the age-old problem of coding games to scale beyond a few cores remains. Just don't try to use it to re-encode hours of 4K video or render a pro-level 3D scene. In the current reality, then, the G4600 is appealing. But change is in the air, and the measure by which CPU value is assessed could be very different within just a few weeks. **–JEREMY LAIRD**

VERDICT 8

Intel Pentium G4600

⊞ **VALUE PROPOSITION** Excellent single-threaded performance; very cheap for an Intel Core-based chip; it's got Hyper-Threading!

⊟ **INDECENT PROPOSAL** Feeble multi-threaded performance; locked CPU multiplier; might not look so cheap once AMD shakes things up.

$82, www.intel.com

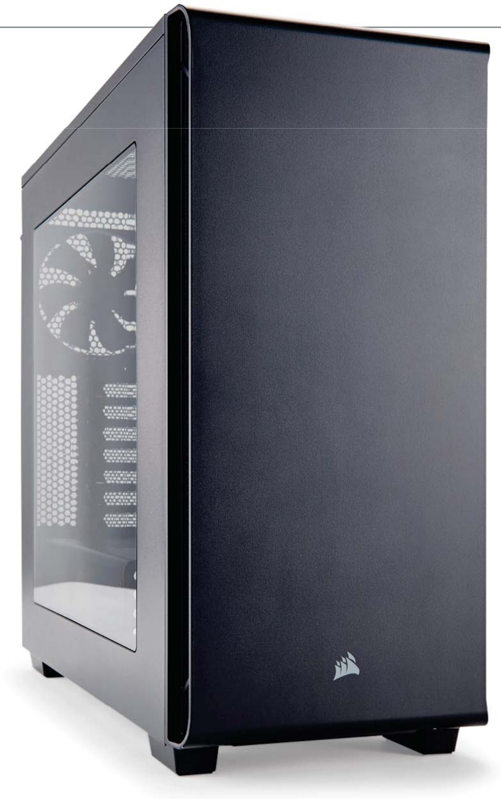
BENCHMARKS

	Intel Pentium G4600	Intel Core i5-7600K
X265 Benchmark (fps)	7.8	**15.9**
Cinebench R15 Single/Multi Core (Index)	151/385	**179/663**
FryRender Benchmark (m:s)	8:56	**5:46**
AIDA64 Memory Latency (ns)	61.3	**58.1**
Power Draw Idle/Load (W)	46/**69**	**44**/103
Total War: Attila @ 1440p (fps)	36	**40**
Far Cry Primal @ 1440p (fps)	76	**77**
3DMark Fire Strike Dedicated GPU (Index)	11,679	**15,762**
3DMark Fire Strike Integrated GPU (Index)	1,003	**1,159**

Best scores are in bold. Our test bench consists of an Asus ROG Maximus IX Hero, 16GB Corsair Dominator Platinum 2,400MT/s, and an Nvidia GeForce GTX 1080.

SPECIFICATIONS

Base/Turbo Clock	3.6GHz/NA
Cores/Threads	2/4
Lithography	14nm
Cache	3MB
Memory Support	DDR4 2,400MT/s
Memory Channels	Dual
Max PCIe Lanes	16
Graphics	Intel HD 630
Graphics Clock	1,150MHz
TDP	51W



Corsair Carbide 270R

Classy chassis comprised of compromise

THERE'S LITTLE WE LOVE more than a case that cuts that fine line between sophisticated and garish. Corsair has long been a master of balancing on that knife point, its chassis beautifully comprised of elegant panels shaped in a manner that would put Apple's design studios to shame. But they've always come at a cost. Literally. Most of the high-end cases pass the $100 mark by a mile, with only the Carbide 400C scraping in just under the margin, and anything else relegated to ITX lovers.

The Carbide 270R bucks that trend. Coming in at a reasonably affordable $70, it's the first Corsair case that incorporates the look and feel of the more sophisticated 400C but at a more aggressive price point. The front panel curves down into a smooth, brushed aluminum-effect plastic finish, with the front I/O tucked away down the side in a recess. You're not spoilt for choice there, though, with a single power button, two USB 3.0 ports, headphone and microphone pass-throughs, a hard drive operation indicator, and a single reset button. On either side (once you get past the front I/O), you'll find a large section of filtered fan intakes, around one inch deep—more than enough to keep your choice of front system fans well fed.

Speaking of cooling, there's room for a 360mm/280mm radiator in the front (3x 120mm fans or 2x 140mm), a 240mm/280mm radiator in the roof (2x 120mm/140mm), and a single 120mm radiator in the rear. Pretty neat, if water cooling is your thing. The vent on the roof is something of a nuisance, though. It's really long—at first glance, you'd be forgiven for thinking you could mount three 120mm fans there. Unfortunately, it's just shy of being the right size for that, although with a touch of modding and some seriously secure screws, it wouldn't be too hard to mount a 360mm radiator in the top, then mount additional fans on to it. However, at that point, it may be worth just buying another chassis. Our biggest gripe with the top fan mount lies with the fact that it's huge and has zero dust-filtering. If you're running any setup other than exhaust, you're going to have a bad time when it comes to keeping the inside of your chassis dust-free, and for a windowed case, that can be a real deal-breaker.

CONSPICUOUS BY ABSENCE

The rest of the chassis is very spartan. There's no 5.25-inch drive bay, no hard drive cages in the front, and a simple three-quarter-length power supply cover across the bottom of the rig, with a cable cutout to route those pesky front panel connectors. Turn the case around, and you're greeted by one huge CPU cutout, two 2.5-inch SSD mounts on the back of the motherboard tray, and two 3.5-inch hard drive mounts on the left-most panel closest to the front. Cable tie points are plentiful, but there are no rubber grommets protecting the cable routing holes. Although not hugely important, it can help hide cable mess, and is something we'd have liked to have seen.

We can't help but go back to that price, too, and compare it to the competition. For $70, you could get NZXT's S340 case, which looks crisper and cleaner, and has substantially better dust filtration systems than the 270R. It is, however, more limited in its cooling support. But if that's a problem, you could swap over to the Fractal Define S instead, coming in at $80, which provides you with full unhinged access to up to two 360mm radiators top and front—but with an increase in size, and the lack of a PSU cover. The Corsair Carbide 270R is a happy medium between the two. It's not perfect, but for the price, it's damn impressive, and definitely one of our top three mid-range chassis. **–ZAK STOREY**

VERDICT
8

Corsair Carbide 270R

+ CARBON FIBER Stylish; good cooling support; easy to build in; PSU cover; intuitive storage design.

− CARBONITE Lack of dust filtering; confusing top cooling mounts; lack of rubber grommets.

$70, www.corsair.com

SPECIFICATIONS

Form Factor	Mid-tower
Motherboard Support	ATX, microATX, Mini-ITX
Colors Available	Black
Window Options	With or without
3.5-inch Support	2
2.5-inch Support	2
Radiator Support	280mm front, 280mm roof, 120mm rear
Fan Support	3x 120mm front, 2x 140mm roof, 1x 120mm rear
Dimensions	20 x 8.3 x 18.1 inches
Graphics Card Clearance	14.6 inches
CPU Tower Clearance	6.7 inches
Weight	16lb

Razer Kraken 7.1 V2

Exploring the depths of bass

THIS IS NOT THE FIRST time Razer has unleashed the Kraken, and it's not the first time we've faced it down. Its first go-around, when we reviewed the shiny white Kraken Pro V1 in December 2015, didn't exactly impress; its bass-above-all-else sound stage was a bit much, and we had trouble with the mic. Can this 7.1 model, which sits alongside the newly-tuned Pro V2, offer us something more palatable?

We'll address the issues we had with the original shortly—let's begin with the benefits (or not) that the 7.1 offers over the Pro model. The most obvious difference is the lack of a four-pole jack, consigning the 7.1 to USB-based use only. There's also a bit of added virtual surround technology, Razer's Chroma LED lighting, a MEMS microphone in place of the Pro's more standard electret number, and active noise canceling through Razer's Synapse app.

Like the V1 before it, this Kraken is a mighty aluminum monster—light, strong, and padded to within an inch of its life. It has even fatter circumaural ear pads—replaceable with oval models, which would suit larger ears, but only if you're willing to pay for the upgrade—and despite its snug fit, this is a headset that you can wear from dawn to dusk without worrying about squeezing or discomfort.

The 7.1 virtual surround is, frankly, a bit weird. It's highly adjustable through the app, but so subtle that it might as well not be there. When you do happen to catch a moving sound, it feels as though the Kraken is painting more of a vertical than horizontal picture, a disconcerting sensation, which throws one out of the game somewhat. The Chroma lighting, similarly, might as well not be there, seeing as you'll ideally be wearing this headset rather than looking at it. It's all about making a statement to those around you; if you've been dying to state "my ears are glowing purple," more power to you.

Here's something the Kraken 7.1 V2 does oh-so-right, though: its 5V-powered microphone. Retractable into the earphone and perfectly poseable, the microelectromechanical, fully silicon-based construction of the mic pulls in a clear, rich, quality sound that's leagues above any tiny electret in this price bracket. The noise canceling is decent, too. This is an utterly, utterly impressive piece of gear. We'd like to see MEMS spread all the way across the mid-level headset market, and it's a valid reason—one that isn't silly pretty lights—to settle for USB-only headset solutions.

BASS CAMP

That's one check in the box, then. So what of that all-important sound stage? We were a bit concerned when Razer described it as "louder" than its older sibling, which we diagnosed with acute Gamer Syndrome, as it leaned so heavily on the bass. Let's begin with the good news: through Razer's 50mm drivers, the crackles of treble and burbles in the middle are present and sound perfectly correct. You won't be dragging anyone in to listen to your new headset, but there's nothing missing, and a rich, satisfying level of sound reproduction is on offer. But then the bass kicks in, and those clear tones get hammered down by a relentless assault of low-frequency sound, boosted to within an inch of its life, and sometimes beyond the point of clarity. It's more pleasant than its predecessor, and you can futz with the EQ controls in Synapse to calm it down a little (or, if you're a real masochist, switch on the unnecessary bass boost), but this headset is positioned as a skull-shaker, and that's precisely what it does. And, overall, it is objectively a better headset than the first wave of Kraken cans.

The microphone is out of this world, the padding luxurious, the gimmicks ladled on, and the sound, er, enhanced. But you'll find a much more balanced sound elsewhere in the market. This is an explosive gaming headset, and if you're not consistently immersed in a world of combat, you'll be disappointed. **–ALEX COX**

VERDICT

7

Razer Kraken 7.1 V2

➕ **CRACKIN'** Tremendous mic; supremely comfortable; tweakable sound.

➖ **CACKIN'** Over bass-heavy; poor 7.1; pointless lighting; USB only.

$99, www.razerzone.com

SPECIFICATIONS

Driver Type	50mm neodymium
Impedance	32 ohms
Frequency Response	12Hz–28KHz
Design Style	Closed back
Microphone Type	MEMS
Connectivity	USB 2.0
Weight	12.3oz
Cord Length	6.6 feet

SteelSeries Rival 700

Perfection in non-ambidextrous form

STEELSERIES: a legend in the hardware world. Its reputation is only trumped by its own new products supplanting itself on the way to the top of the peripheral hill. The company is neither the huge production foundries of Logitech, churning out hundreds of thousands of products each year, nor the niche-audience-slaying design houses of Mionix or BenQ Zowie, but a happy mix of the two. And that balance speaks volumes. With a legacy encompassing products such as the Sensei ambidextrous gaming mouse, the HV3 lineup of headphones, and even the first ever Rival, SteelSeries has definitely cemented its place in our hearts when it comes to those additional little input methods we use on our prized systems.

That said, mouse development seems to have come to a grinding halt, certainly as far as innovation is concerned. With high-dpi optical sensors now perfected, RGB lighting mastered, and a plethora of mice in a variety of shapes, sizes, and button complements, it's hard to imagine where the pointy rodent will go next. Well, that's what we thought, until two mice in particular caught our attention in the last 12 months: Mionix's vital-statistics-tracking Naos QG, and SteelSeries's extravagant flagship, the Rival 700. We didn't manage to get the latter into the mag at the time—not for lack of trying, mind you. We initially had our hands on a sample in the office way back in April 2016, when we thought it was absolutely fantastic. However, due to SteelSeries's concerns with the braided cables being too "grippy," the company (frustratingly) delayed the release, and took the mouse back to the drawing board for another four months, to redesign the cable—yep, SteelSeries is that serious.

THINKING OUTSIDE THE BOX

So, here we are at last, with the mythical beast sitting in front of us. The SteelSeries Rival 700. We rarely speak about the unboxing experience in our reviews, but with the Rival, it's something else. You get a small rectangular box, split diagonally. Opening it up on its hinge reveals nothing more than the mouse itself and a small cardboard box. You'd be forgiven at this point for thinking that the Rival 700 is a wireless mouse—it's only when you dig a little deeper that you begin to understand what's going on. In short, the choice of cable rests with the consumer. You get one six-foot braided cable, one six-foot plastic-coated cable, plus a plastic-coated three-foot cable. On top of that, you can also swap out the cover on the rear belly of the mouse to either a glossy black or an anti-sweat soft-touch variant instead ($15 for the pack).

And then, of course, there's the sensor. By default, the Rival 700 comes with an optical PixArt 3360, pumping out a whopping 16,000 dpi if needed, with zero hardware acceleration. However, if optical is simply not your jam, you can grab yourself the PixArt 9800 laser module instead for $25. Simply unscrew the four Phillips-head screws underneath, place your new sensor inside, and wham-bam-thank-you-ma'am, you're all set.

Customization aside, there's a few little extras that really make the Rival 700 stand out. You can't quite seen the OLED screen in the above shot, but it enables you to slap any number of small GIFs or images on the side of the mouse, alongside in-game notifications—not particularly useful, granted, as you should be looking at the screen. But what's most impressive is the inclusion of rumble feedback—you can assign tactile feedback to any of the seven buttons, in a variety of ways. Although not hugely useful for the two main buttons, having a tactile response from whichever button you press helps train your brain to use buttons that you would otherwise get confused about, making it one neat and surprisingly useful addition. The vibrations themselves are exceedingly precise, and don't cause any jitter in your mouse positioning. We bound this feature to one of our focus buttons in *Sniper Elite V3*, and had no trouble picking off targets at our usual rate.

All in all, the SteelSeries Rival 700 is a well-tuned, customizable gaming mouse at the pinnacle of its field, designed to incorporate absolutely everything in today's gaming mouse market. It does cost $80, which is a lot for a pixel-pointer, but it's well worth it in our eyes. **–ZAK STOREY**

VERDICT 9 KICK ASS!

SteelSeries Rival 700

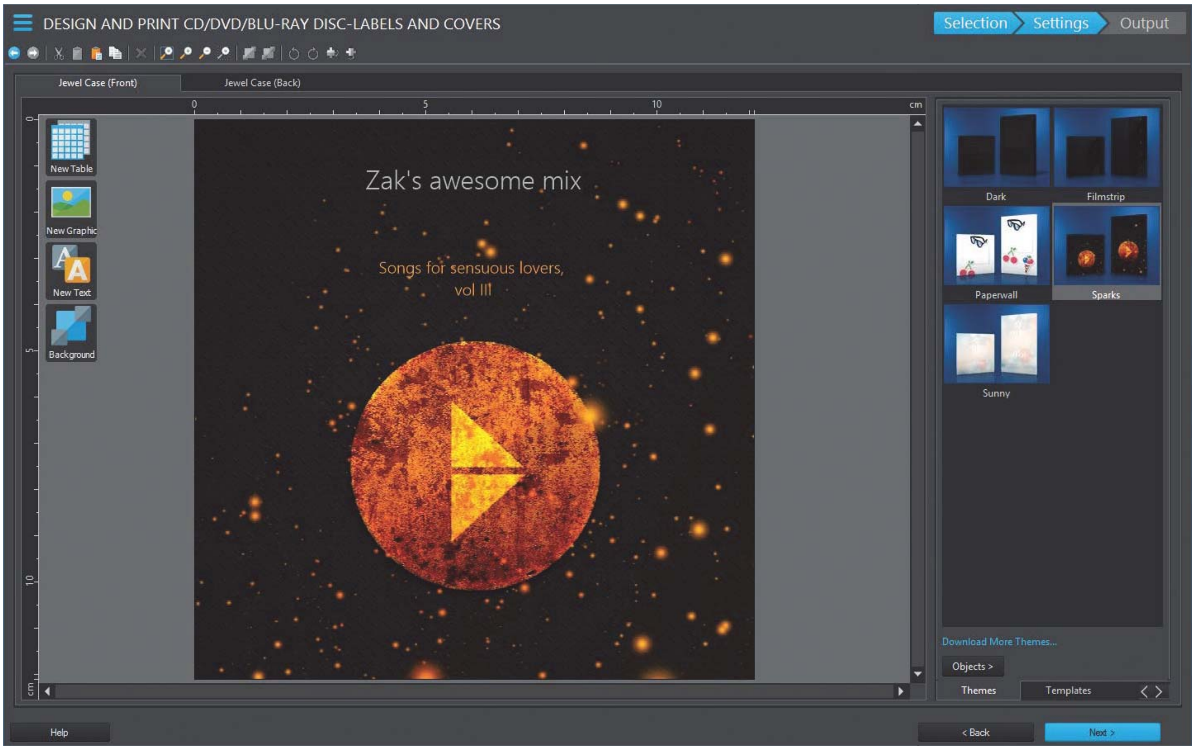
⊞ **TRUMP VS. HILLARY** Fantastic optical sensor; strong ergonomics; no hardware acceleration; classy design; strong software suite; tactile feedback; swappable cables and sensor.

⊟ **MCDONALD'S VS. BURGERKING** A touch too pricey.

$80, www.steelseries.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	100–16,000 dpi
Sensor Model	PixArt Technologies PMW3360
Polling Rate	125Hz, 250Hz, 500Hz, 1,000Hz
Programmable Buttons	7
LEDs	Two-zone—16.8 million colors
Cable Lengths	6ft and 3ft
Weight	4.8oz



The cover designer has a few graphics to get you started, or you can import your own.

Ashampoo Burning Studio 18

For those who haven't dumped the optical drive

WE LIKE ASHAMPOO. It's hard to hold anything against a software company whose slogan is "We make software!" And we admire its directness—even if we're not totally sure about that name.

We respect it, too, for still making burning software in 2017, when the world has long since moved on to flash or cloud storage for transferring files. There are a great many uses for those shiny disks, however, and with BDXL discs capable of holding 100–128GB of data, the market for them as an archivable backup solution is strong. But in a world where you can find DVD burning apps for free on the Internet, why go to the effort of paying for one?

Fans of the *Burning Studio* series will no doubt be wondering why Ashampoo has done a Microsoft and skipped a number, going straight from *Burning Studio 16* to *18*. Something to do with 17 being an unlucky number, apparently, and anyone who's felt better for noticing that a building lacks a 13th floor will surely sympathize with that.

So, what's here that's worth paying for? Free apps tend to be limited in scope, so having every feature in one place is certainly nice. Along with the standard burning of data folders to a disc, and the production of audio CDs, you get a mode that tunes a disc especially for the model of stereo in your car. Now, we've never had a problem getting in our Benz and worrying that a CD might have been made with a Ford in mind, but we're talking about MP3 CDs here, and not all car stereos want the same folder structure from a disc, so it's a thoughtful inclusion. The app also includes an equalizer for tweaking the output of your music files when burning as a standard audio disc.

Movies get a similar level of attention to detail—with MPEG-4, H.264, and AAC added to the list of supported formats, the masterpieces you shoot on your cell phone can be committed to shiny polycarbonate for posterity. That these are also common formats found on torrent sites (or so we're told) is merely a happy accident. The app wants to be an editing suite, too, bringing in cuts and transitions, sound effects, photo slideshows, and a cover designer.

It's also a backup app. Large amounts of data can be stored across multiple discs, thanks to disc-spanning, and there's compression and password-protection, too. The main reason you'd want to do this rather than chuck everything on a suitably sized external hard drive is longevity—while most disc formats offer only a lifespan of up to five years, Millenniata's M-Discs claim up to 1,000 (although this is difficult to test; we're working on communicating with some cyborg future-Zak to find out if they live up to their promise). That's the kind of long-term data archival capability untouched by hard drives.

You're mainly buying convenience and peace of mind when you purchase an app like this. With so many functions bundled into one package, you'd have to skip across several free apps to get the same level of service, and deal with a dearth of updates, or poor coding, or a lack of compatibility with disparate hardware. If disc-burning is still something that's important to you, *Burning Studio 18* is packed full of features and works well. Anyone else should just buy a big USB drive. **–IAN EVENDEN**

Ashampoo Burning Studio 18

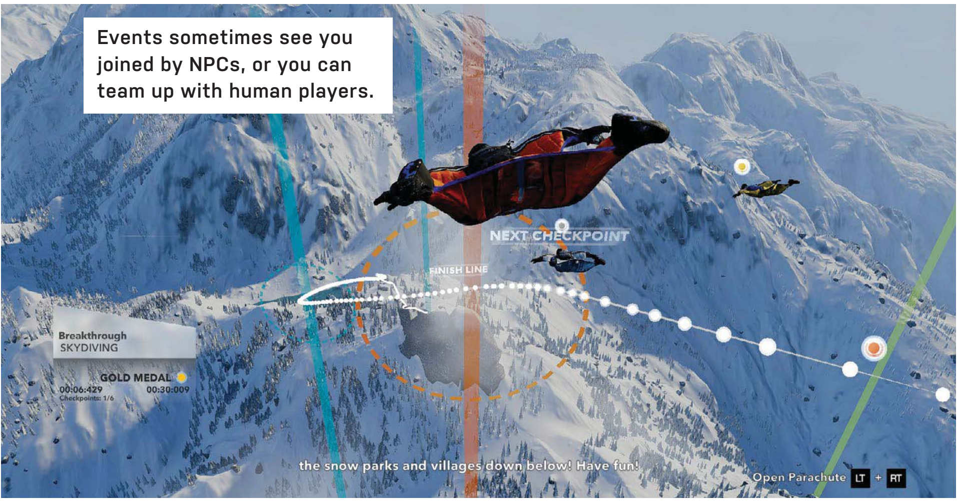
VERDICT 7

THE BURN Comprehensive features; useful backup capabilities; straightforward to use.

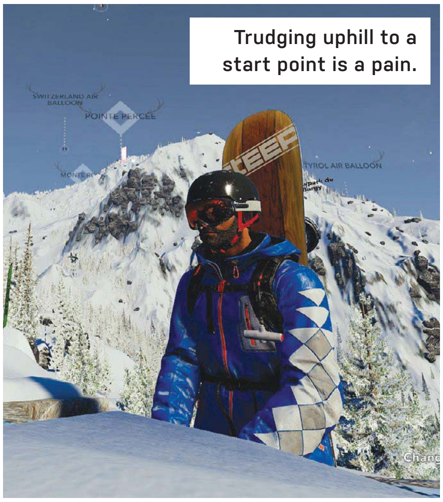
THE BIRD Many PCs now sold without optical drives; 2TB hard drives are cheap .

RECOMMENDED SPECS Dual-core 1.8GHz CPU; 2GB RAM; at least 128MB VRAM; Windows 7 or newer.

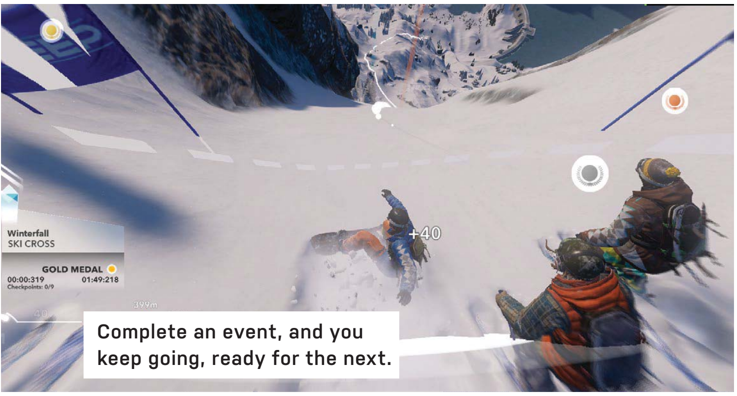
$60, www.ashampoo.com



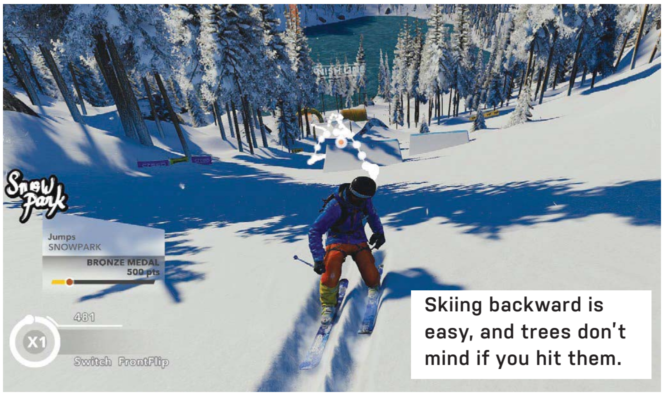
Events sometimes see you joined by NPCs, or you can team up with human players.



Trudging uphill to a start point is a pain.



Complete an event, and you keep going, ready for the next.



Skiing backward is easy, and trees don't mind if you hit them.

Steep

We can see our house from heeeeeeerrrrrre!

THERE'S A POINT in *Steep* when the mountain starts talking. It has an echoing, female voice, the sort of thing you'd expect from millions of tons of rock if it had been possessed by the spirit of Galadriel, perhaps seeking a winter getaway.

It's odd, because you're not expecting it—up to this point, you've been encouraged to jump off things, and whoop it up—and what the mountain says cuts to the heart of what Ubisoft intended with the game. It describes itself as a playground, a place to make memories, and takes things too far by pretending to be puzzled by the weird "skis" people are using on its slopes.

Skiing is one of four sports in the game—five, if you count walking. There's snowboarding and paragliding, too, or you can ease into a wingsuit, dragging one of *Far Cry 4's* more distinctive modes of transport out of the closet, and jump off a mountain whenever the mood takes you.

Graphically, there's a lot of white, although special mention has to be made of the crunchy snow simulation, even if it sometimes appears too "digital"—your board leaves a distinct pattern of depressions, rather than cutting smoothly through—and the curious lack of feedback from running over someone else's trails. The ability to change the time of day is a nice touch, as are the hot air balloons, anchored somehow in the air above the Alps to provide additional launching points for wingsuiters.

Imagine a *Far Cry* game with no main quest drawing you to specific areas. Instead, wherever one side-quest takes you, you pick up three more. You can go where you want, and progress is made by completing events, scoring points by performing tricks, discovering areas, missing obstacles, and finding creative routes down the mountain. As you advance, more areas unlock, and you get a feel for the mountains. They really are a playground, with no penalties for messing up, and speedy restarts if you really can't get back to the course.

We had a few moments when we couldn't, the game finding it impossible to decide what to do with our boarder when he encountered the back of a building, or one of the interminable snow fences that litter the landscape. Instead, it decided to spin him around, flipping from left to right so fast that the game couldn't keep up (the frame rate was locked at 60 for most of our time with the game, sacrifices being made in the fidelity of distant objects rather than let the fps dip). And once *Steep* crosses the line from a game about barreling down hills as fast as you can to one of pure analog control, that mountain's words start to make a lot more sense. This is a playground, and it's through exploration and having fun that you can make it your own. **–IAN EVENDEN**

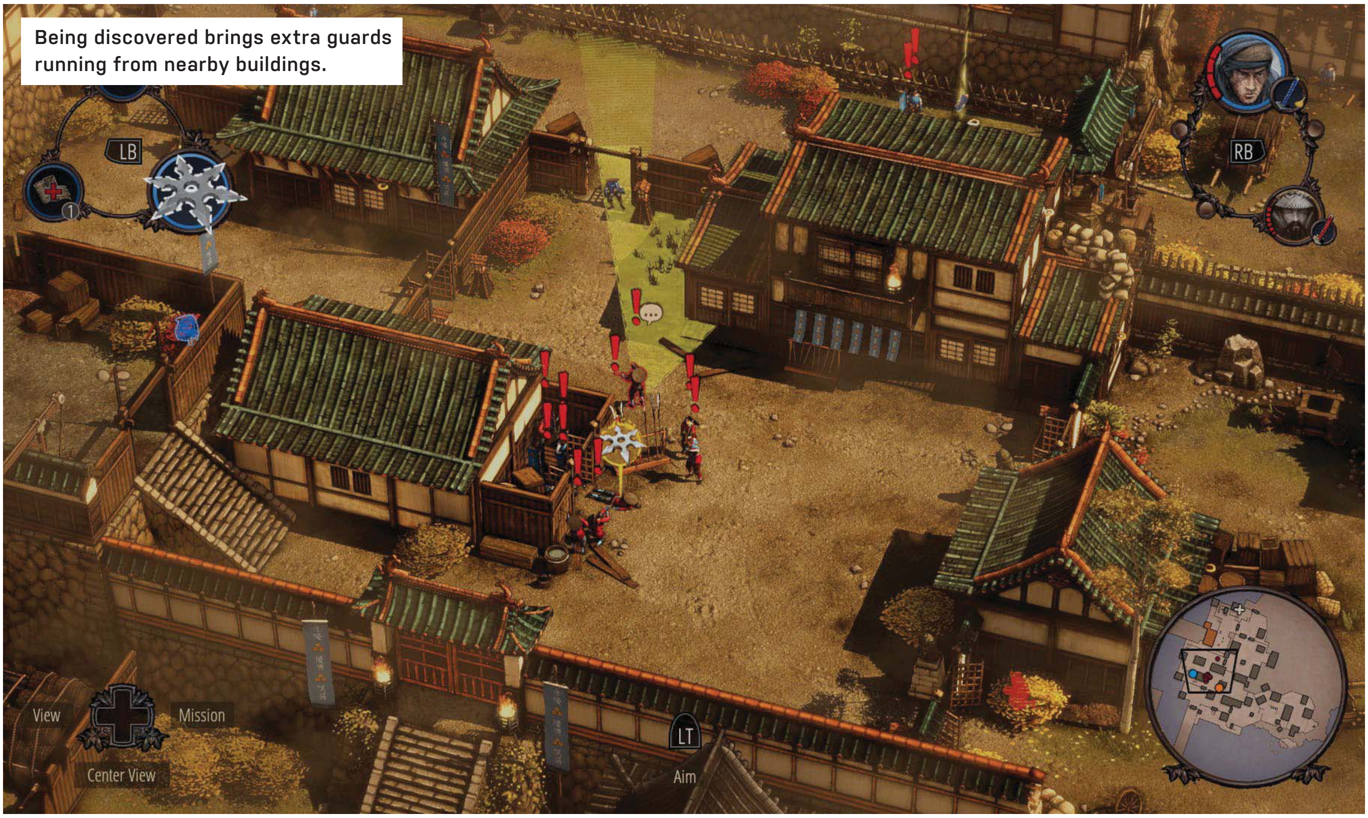
VERDICT 8 **Steep**

+ DEEP Good sense of speed; plenty to discover; well-calibrated controls.

− WEEP Occasional glitches; inconsistent collision detection; patchy signposting.

RECOMMENDED SPECS Intel Core i7-3770K @ 3.5GHz or AMD FX-8350 @ 4.0GHz; 8 GB RAM; GeForce GTX 970 or Radeon R9 390.

$50, http://steep.ubisoft.com, ESRB: T



Being discovered brings extra guards running from nearby buildings.

Shadow Tactics: Blades of the Shogun

Shadow tactics: stand by wall with sun behind you

FROM A ROOFTOP, you see it all. The guards move in predictable patterns, their vision cones making it explicit what they can and can't see. Your samurai partner is in some bushes just behind a guard and his officer, though neither is looking in his direction. Up high across the map, a sniper awaits your command. All you have to do is spin the winch, and a crane will drop its load on three guards, while your samurai cuts down his two, and the sniper drops the remaining witness. They carry out their orders simultaneously, and there's nothing left to stop you entering the next area.

Shadow Tactics' name reveals its purpose. A top-down stealth game, rendered in a lovely, painterly style, it's probably not pushing your GPU as hard as *Dishonored 2* would, but taxes the wetware between your ears just as much. Its world is one of predictable patterns and overlapping attention spans. Opportunities overlap, coalesce, and dissolve as you watch, until you judge the moment is right to strike.

With up to five characters under your control, attacks can get complex. You can use your heroes one at a time, but entering Shadow Mode allows you to set up moves in advance, which are then carried out at the press of a key, and this can lead to perfectly timed ambushes or, more likely, abject failure. So load and have another go. The game absolutely encourages you to quicksave, even going as far as assigning it a button on the controller, if you're using one. It nags you if you've spent as much as an entire minute without saving, but only offers your last three saves for reloading. This makes it a game in which trial and error are the way forward, but one that's not going to punish you too badly for making the latter, despite its occasionally punishing difficulty level.

It may be set in Edo-period Japan, with shogun, samurai, and shinobi taking major roles, but *Shadow Tactics* evokes a later period in world history and an earlier one in videogames: the WWII-set *Commandos* games. This isn't a bad thing, as it's always good to see fresh ideas pumped into a stale genre. It's been 14 years since *Commandos 3: Destination Berlin,* which now sounds rather like a movie portraying a bachelor party, in which someone thinks it's hilarious to dress up as a Nazi, rather than a gritty wartime tactics game.

In doing this, *Shadow Tactics* feels like something new, even if it's just the latest point on a line that stretches back to the original *Syndicate.* It would be easy to imagine this harsh but mostly fair game in third-person, *à la Hitman,* but we're glad it's remained the way it has. **–IAN EVENDEN**

VERDICT 8

Shadow Tactics: Blades of the Shogun

+ LIGHT Engaging tactical gameplay; appropriate art style; simple control scheme.

– DARK Can obscure the way ahead; animations rely too much on bobbing heads; quicksaving may annoy purists.

RECOMMENDED SPECS Intel i3 fourth-gen 3.5GHz or AMD quad-core 3.9GHz; 6GB RAM; Nvidia GTX 570 or AMD Radeon HD 6950.

$40, www.shadow-tactics.com, Not ESRB rated

LAB NOTES

JARRED WALTON, SENIOR EDITOR

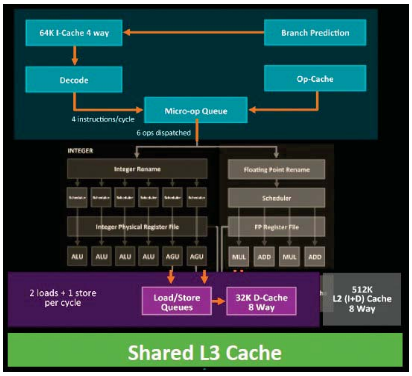
AMD's Ryzen Looks Promising

Double the cores, double the fun, but no six-pack

I'VE BEEN HEARING about AMD's Zen, now Ryzen, for what feels like forever. The Zen architecture was first mentioned in 2012, and ever since, the repeated refrain of AMD CPU apologists has been "just wait for Zen." That wait is finally over, and Ryzen is now available. But as we go to print, I still don't know exactly what AMD's Ryzen lineup will be in terms of core counts, clock speeds, and pricing. It's quite the contrast compared to AMD's open discussion of the Ryzen architectural details, not to mention Intel's routinely leaked product roadmaps.

Here's what I do know. AMD is planning on a full release of Ryzen processors, all multiplier unlocked. Ryzen uses a quad-core module as its building block, with SMT providing eight threads, similar to Intel's Hyper-Threading, and 8MB L3 cache. AMD claims a 40 percent improvement in IPC compared to its existing Excavator architecture, with clock speeds of at least 3.7GHz on the eight-core part. Architectural changes include a reworked, more efficient pipeline. Each core is a six-wide superscalar design (four-wide fetch), compared to the previous four-wide design, the branch prediction is more accurate, and cache latencies and bandwidth are both improved. The result is that Ryzen should be much more competitive with Intel's CPU offerings.

Interestingly, AMD apparently won't have a six-core model; instead, it will have an eight-core chip without SMT as its mid-tier offering. That means that at each product segment, AMD will deliver double the cores/threads as Intel. Intel will almost certainly maintain its lead in per-core performance, but if 4C/8T Ryzen SR3 goes up against Core i3's 2C/4T design, or 8C/8T Ryzen SR5 versus Core i5's 4C/4T, even with slightly lower clock speeds, Ryzen should come out ahead in many benchmarks. We'll have the full skinny next month.



Making AMD CPUs competitive again.

TUAN NGUYEN

Editor-in-Chief

There's this trend in the PC space called "gaming." What does that mean? Contrary to what you might think, it's hardware that puts aggressive aesthetics and RGB lighting before useful innovation. Manufacturers are marketing the living diodes out of hardware, and attaching the word "gaming" to just about anything. Unsurprisingly, a lot of "gaming" gear doesn't do anything for actual gaming performance. It just means you're going to pay more for something made cheaply, to cash in on the gaming train. This isn't about choice or taste. It's about the definition of gaming. Give me quality and performance over marketing hype and gimmicks any day. I'll take the cost savings, too.

ZAK STOREY

Reviews Editor

Why don't we include the price of the operating system in our builds and system features? It's a question that often comes up in the office. For the most part, we shy away from the decision, because the needs of the individual vary massively across all of our readers—some use Ubuntu, others Debian, Windows 7, 10, and so on. That said, if you're resolutely stuck on Windows, but don't want to cough up $100 for the latest version, there is another option: the Windows Insider Program. Simply create a Windows Live account, sign up to the Insider Program, download and install the Windows 10 technical preview, and you get a fully unlocked version of Windows 10 for free.

Editors' Picks:
Digital Discoveries

Bo Moore, technology editor, and Alan Dexter, executive editor, share their latest tech loves

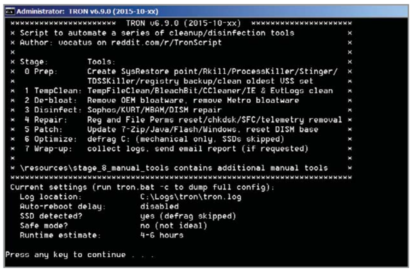
TRON V9.9.0

Being my family's on-call tech support, I've run into my fair share of systems compromised by a pile of bloatware, unnecessary toolbars, and viruses. Most of us know the standard system recovery utilities—CCleaner, Malwarebytes, and their ilk—but there's an even better option, before going nuclear, and reinstalling the OS.

Tron is an open-source script that automates the full process of cleaning and disinfecting a Windows system. First, it preps your system, creating a restore point, and running tools and scripts that ensure the rest of the process runs smoothly. Next, it runs cleaning utilities such as CCleaner and BleachBit, followed by de-bloating, ditching OEM bloatware, toolbars, and other pre-installed apps (excluding useful stuff such as Calculator and Paint). Disinfection is handled by Malwarebytes, KVRT, and Sophos, while a series of scripts check and repair Windows. Finally, Tron updates and optimizes your system, patching Adobe, Java, and whatever else needs updating.

It's an impressive list of tasks that should take care of almost any problem. Even better, it's a single download that, once started, runs itself—though it can take six to eight hours to finish.

Free, www.bmrf.org/repos/tron



Administrator: TRON v6.9.0 (2015-10-xx)

```
**********************  TRON v6.9.0 (2015-10-xx)  ********************
* Script to automate a series of cleanup/disinfection tools           *
* Author: vocatus on reddit.com/r/TronScript                          *
*                                                                     *
* Stage:        Tools:                                                *
*  0 Prep:      Create SysRestore point/Rkill/ProcessKiller/Stinger/  *
*               TDSSKiller/registry backup/clean oldest VSS set       *
*  1 TempClean: TempFileClean/BleachBit/CCleaner/IE & EvtLogs clean   *
*  2 De-bloat:  Remove OEM bloatware, remove Metro bloatware          *
*  3 Disinfect: Sophos/KVRT/MBAM/DISM repair                          *
*  4 Repair:    Reg and File Perms reset/chkdsk/SFC/telemetry removal *
*  5 Patch:     Update 7-Zip/Java/Flash/Windows, reset DISM base      *
*  6 Optimize:  defrag C: (mechanical only, SSDs skipped)             *
*  7 Wrap-up:   collect logs, send email report (if requested)        *
*                                                                     *
* \resources\stage_8_manual_tools contains additional manual tools    *
***********************************************************************
Current settings (run tron.bat -c to dump full config):
  Log location:            C:\Logs\tron\tron.log
  Auto-reboot delay:       disabled
  SSD detected?            yes (defrag skipped)
  Safe mode?               no (not ideal)
  Runtime estimate:        4-6 hours

Press any key to continue . . .
```

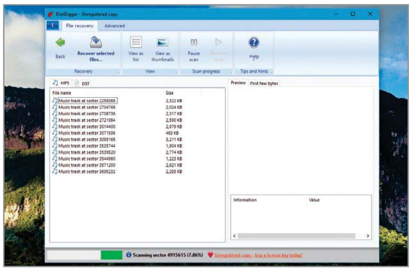
DISKDIGGER

My smartphone recently decided that it no longer liked my microSD card. I can't remember if it was after a restart or update, but my screen displayed a prompt saying that the Samsung microSD wasn't recognized, and would I like to try to format it? An offer that the phone couldn't deliver on, as it appeared to have been corrupted. Long story short: No matter how many machines, adapters, tools, and OSes I tried, I couldn't get the card to play nicely again.

A dead microSD card is hardly the stuff of nightmares, particularly as the data that really matters was automatically uploaded to my Google account. Even so, it'd be good to take a look at what's on the card before I consign it to the big trash bin in the sky.

The problem is that Android 6.0 has changed the way it handles SD cards, so plugging the card into Windows (or Linux) reveals nothing. So I turned to file recovery tools to see what was lurking beneath its seemingly blank surface. One tool that did well, and was free to try, was DiskDigger—a portable app that scans for a selection of files, and allows you to save them off with minimum fuss. It took a while to scan the entire card (30 minutes for 32GB), but did recover a few MP3s and a couple of log files.

$15, www.diskdigger.org



File name	Size
Music track at sector 2258368	2,322 KB
Music track at sector 2704768	2,024 KB
Music track at sector 2708736	2,317 KB
Music track at sector 2721984	2,590 KB
Music track at sector 3014400	2,979 KB
Music track at sector 3071936	483 KB
Music track at sector 3095168	3,211 KB
Music track at sector 3535744	1,904 KB
Music track at sector 3539520	2,774 KB
Music track at sector 3544960	1,223 KB
Music track at sector 3571200	2,621 KB
Music track at sector 3695232	2,293 KB

Scanning sector 4915615 (7.86%)

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GEEK TESTED & APPROVED

Antlion ModMic4

WE HAVE A PENCHANT at *Maximum PC* for high-quality audio. Although there are some pretty snazzy gaming headsets, they tend to meander well into the $250-plus range for anything close to decent sound reproduction.

Turn your head to audiophile offerings without a microphone, however, and you can easily find pairs for under $150 (Audiotechnica's ATH-M50Xs, for example). For the vast majority, no mic is no problem, but for gamers, lacking a way to communicate with your buddies can be a deal breaker. And for those unwilling to chunk out for a $200 dedicated desktop microphone, there's not a huge deal of choice.

Except, maybe there is. Antlion saw this gap in the market, and jumped in with this fantastic modular microphone.

Available in two models, the 4 and the 5 (the 5 has both a four-pole and a USB adapter), the ModMic attaches to the side of any headset with a small adhesive magnetic clip. Don't need the mic today? Pull it off your headset, and place it in its faux leather case. Sound quality is impeccable, and the mic supports up to 24-bit 192KHz without worry, delivering some fantastically crisp and clean sound; not too bass-heavy, not too tinny. The adhesive sticker is easy to remove, and it comes with a variety of clips to secure the ModMic's cable to your standard headphone cable, too. There's very little to dislike—we just wish it rotated a bit better on that magnetic mount. **–ZS**

$50, www.antlionaudio.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON…

> Replacing Fans
> Core i5 vs. Core i7
> OwnCloud Woes

Cooler Fans

Zak's piece on his upgrade build had me reading it at least six times to make sure I learned all there was to be learned ("The Ultimate Upgrade," Feb 2017, pg. 68). There was one confusing part, though: I could not tell if he replaced the very good stock fans on the new NZXT Kraken cooler with Corsair MLs, or if he added them to the inside of the radiator, meaning the radiator would have four fans in push-pull. I can't tell if the two stock fans are there on the front of the case, or if he discarded them and replaced them with the Corsair MLs.

For a new builder, fan placement and control is very confusing.

My first build is about to be the Kaby Lake i7-7700K, Be Quiet! Dark Base Pro 900, and I just switched the cooler from the Corsair H115 to the NZXT Kraken X62, which he loved in his build (you used the 52, but also said 240 radiators now had less appeal, and suggested 280 radiators, with 140 fans). I'm also using the MSI GeForce 1080 Seahawk X GPU, which has a radiator and included Corsair fan.

That means I have three brands of new PWM LED fans to deal with: the three Be Quiet! fans on the case, the Corsair fan on the GPU radiator, and two NZXT fans on the Kraken cooler. All of these stock fans are LED and PWM. I was tempted to change them for matching Corsair MLs with white LEDs, but decided not to. Zak added two Corsair fans to the inside of the Kraken radiator. Did he replace the two stock fans on the Kraken radiator with the two Corsair MLs, or are there four fans in push-pull? **–Greg Johnson**

REVIEWS EDITOR ZAK STOREY RESPONDS: The fan situation was a mixed bag. I knew I wanted to use Corsair's ML120s, because I wasn't massively fond of Corsair's old-school SP series, due to the excessive noise they produced. The ML120s drop well below 500rpm, and produce Noctua-rivaling figures, so they were definitely my preference.

Originally, due to the lack of available airflow in the S340 Elite, I intended to run the Kraken X52 in a push-pull configuration, like you said. I actually went out and bought another two ML120 Pros—but just the standard ones. Theory being, I could place them in push configuration, at the front of the radiator, out of sight, and then have the LED variants pulling air through, while on display.

Unfortunately, the cable tidy bar NZXT includes stops you from installing an additional pair of fans inside the chassis, because the bar sticks out at an odd angle at the top, preventing the radiator or fans coming back any further. On top of that, you can't mount them outside the chassis in the inch of space given by the front panel for airflow, as you'll suffocate them, and there's also the magnetic dust filter in the way, too.

I'm a bit particular when it comes to cooling, and prefer all the fans to be the same model, as (I like to tell myself) it gives me a greater understanding of the noise and airflow I'm passing through the system. I also love consistency when it comes to aesthetic decisions like that. So, I'm not actually using push-pull, but if I could, I would.

Apples and Oranges

On page 53 of the February issue, the table says the Core i5-7600 is 31 percent faster than the Core i7-7700T (3.8 versus 2.9Hz). This surprised me. A few years ago, I got a Core i7 with a Lenovo T440P, and was never that impressed with the speed. I just assumed it would be faster and better than any Core i5. Now I'm confused about what to buy when I next upgrade in a year or two. I'm a business user, with some heavy computing with Visio plugins, running semantic web inference engines, and I use Lightroom a fair bit, but no video editing. I'm not a gamer. The last game I played was *Q-Bert* at a grocery store in 1980. I got addicted and quit, cold turkey. **–Michael Uschold**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: The frequency of a processor shouldn't be confused with its performance. A single-core CPU running at 5GHz will be thrashed in most metrics by a quad-core chip running at 2.5GHz. Generational improvements can also be a factor—a modern chip running at the same frequency as an older model will outperform it, especially with laptops—a lot of Intel's advances have focused on mobile.

As far as your specific comparison goes, it is a bit

↘ submit your questions to: comments@maximumpc.com more complex, because you're pitching a full-fledged desktop Core i5 (the 7600K has a TDP of 91W) against a low-power Core i7 (the 7700T has a TDP of just 35W). So while the Core i5-7600K does run at 3.8GHz, and the Core i7-7700T runs at 2.9GHz, they're designed with very different uses in mind—the Core i7 can be found in tiny NUC-sized machines, while the 7600K is for more bullish systems.

Given what you use your machine for, though, I'd recommend a top-end Core i7, although which particular model you go for depends on what machine you're looking to buy—your options for laptops are more limited by thermals than what you'll see in desktops, and some of Intel's naming conditions can be confusing (the Core i7-6500U, for instance, only has two cores), so it pays to look at the details.

Raspberry Cloud

I am having trouble with the "Create a Pi Cloud with OwnCloud" feature from the November issue, and have spent hours trying to figure out issues on my own. I am having trouble installing OwnCloud (the current version is now 9.1.3). Yes, I did read the update in the "Letters" of the magazine's Holiday 2016 issue.

Here is where I am stuck:

```
sudo chown -R www-data: /var/www/html/owncloud/{apps,config,themes,updater,.user.ini}
chown: cannot access ‘/var/www/html/owncloud/apps’: No such file or directory
```

–Joseph Keller

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: There's no doubting the appeal of running your own cloud server, but getting a server up and running isn't always easy. Even with a detailed tutorial that runs through the main installation, there's going to be problems—in order for it to work, there are certain dependencies that need to be sorted, such as a working database to operate from, a web server to integrate with, and a whole host of permissions to sort out.

While it looks like it's file ownership that has tripped you up, the fact that you're getting a "No such file or directory" error suggests it's the previous step that has failed. Just to recap the process: You need to download the latest version of OwnCloud from **https://owncloud.org/install**, making sure you get the OwnCloud server build, the one that has the "tar.bz2" extension. Next, go into a terminal window, and make your way to wherever you've downloaded it, then unpack that tarball with:

```
$ sudo tar -C /var/www/html -xf owncloud-9.1.3.tar.bz2
```

Make sure the files are unpacked by browsing to /var/www/html/, and making sure there is an "owncloud" directory, and there are files inside it. Only then can you change the ownership of those files.

We ran through the whole tutorial again, just to make sure (using a laptop running Ubuntu 16.04, which forced us to do a few things differently), but it definitely does work. So keep going, and good luck!

Not an Upgrade

I do not agree with the fuss Alan Dexter made about Windows 10 activation, and, based on Windows 10 licensing, I don't believe he was eligible for activation of Windows 10 on his computer.

What he describes as an upgrade is really a new PC. So, to expect Microsoft to recognize that he had done a simple upgrade to his PC is ridiculous. There was nothing left in the machine to identify the old computer.

It is also obvious that he was basing his complaint on an OEM license, which is not transferable to a new computer. The idea that he considered this an upgrade is baffling. I have done upgrades with a fresh install of Win 10 without a key, and Win 10 activated automatically because it recognized the computer.

Your magazine caters to advanced computer users, and your readers expect advanced technical info and advice. **–William LeDuc**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: We've upgraded lots of machines without issue here on *Maximum PC,* but that wasn't the point of my rant—it was the fact that the process can go wrong, and when it does, it's frustrating. For instance, when you say, "there was nothing in the machine to identify the old computer," I assume we have to ignore the SSD? Or the fact that said installation was tied to a Microsoft Live account?

Just to reiterate why I had to upgrade in the first place, it wasn't on a whim; it was because the motherboard had failed. And as a seasoned upgrader, you'll know that when your motherboard dies, it isn't always easy to find direct replacements, so before you know it, you're looking at a major overhaul. There's nothing in the Microsoft licensing agreement that prevents this, at least on a full or upgrade license. As you say, an OEM license does prevent certain upgrades (and, indeed, direct technical support), but that wasn't the case here—something underlined by fact that the machine was activated after talking to a support engineer.

While you may not agree with the fuss I made, and it may not line up with your experiences, highlighting problems where they exist, and making our readers aware of potential problems (and their solutions) is part of what we do here on *Maximum PC.*

[NOW ONLINE]

WHICH GRAPHICS SETTINGS SHOULD I DISABLE?

We love cranking game settings up to 11. But even with top-end hardware, there are some settings that offer little visual difference but can have a large impact on your frame rate. And if you're running on older hardware, you should turn these down to boost your frame rate without making everything look terrible. Graphics options and their impact vary from game to game, so it's a good idea to check out a game-specific optimization guide, but we've come up with a selection of settings that generally provide the least "bang for your buck" in terms of detail versus performance. http://bit.ly/2jplvKh

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THE BUILDS

BUDGET

INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Evolv ITX		$70
PSU	EVGA 450B Bronze		$45
Mobo	MSI B250I PRO Mini ITX	**NEW**	$90
CPU	Intel Pentium G4600	**NEW**	$90
GPU	Zotac GeForce GTX 1060 Mini 3GB		$195
RAM	8GB (2x 4GB) Avexir Core Series DDR4-2400	**NEW**	$52
SSD	240GB PNY CS1311	**NEW**	$60
HDD	1TB Hitachi Deskstar 7,200rpm 3.5-inch SATA	**NEW**	$44
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit		$16

Approximate Price: $662

WHAT A PRICE DROP THIS TIME AROUND! This issue enlightened us about one key tidbit of information when it comes to system building: In this day and age of supercharged IPC performance, the desire for a more substantial processor on a base system like this is null and void. As long as your GPU has the necessary heft, and you're buying a modern CPU, you're not likely to encounter any bottlenecks. This is where the Pentium G4600 comes in. At $90, it's a wallet-pleasing $115 cheaper than the Core i5 we recommended in last month's issue—and, honestly, you won't lose a lot by jumping ship. And if you're just looking for a standard office PC, you can strip out the GPU, swap out the SSD for a 120GB variant, along with a 500GB HDD, and that'll take this already paltry figure all the way down to an outstanding $438—not including a copy of Windows 10, of course (which we talk about on page 92).

MID-RANGE

INGREDIENTS

PART			PRICE
Case	NZXT S340 Elite		$100
PSU	EVGA SuperNOVA 550 GS Gold	**NEW**	$80
Mobo	MSI Z270 Gaming M3	**NEW**	$160
CPU	Intel Core i5-7600K	**NEW**	$250
Cooler	Corsair H100i v2		$103
GPU	EVGA GeForce GTX 1070 SC Gaming ACX 3.0		$390
RAM	16GB (2x 8GB) G.Skill V Series DDR4-2400	**NEW**	$92
SSD	256GB Intel SSD 600p M.2 PCIe	**NEW**	$100
HDD	Western Digital Blue Series 1TB 7,200rpm	**NEW**	$50
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $1,425

KABY LAKE COMETH, and although it seems to have added very little to overall performance, it's difficult to argue with a new chipset and slightly better performance for the same price. This month, we decided to piece together something of a themed build. This checks all those clichéd red and black boxes, the color scheme that's become synonymous with gamers. We also decided to change a few things around in an attempt to bring the storage up to modern-day standards—or at least, more modern. Dropping Samsung's 850 Evo 250GB SSD, we went with Intel's 600p M.2 PCIe SSD instead. At only $3 more, this budget offering tops out at nearly 1,600MB/s sequential reads for snappy program load times. Trying to scrape back a bit of cash, we dropped the WD Black drive for a Blue variant instead, saving us a sweet $25, and we also went for an ever so slightly cheaper kit of DDR4.

TURBO

THIS MONTH HAS SEEN the biggest changes ever hit to our Turbo build. We decided it was time we appeased the small form factor gods by opting for this classy yet powerful microATX system. The decision came about primarily because of the phenomenal saving we could achieve on the EVGA X99 Micro 2. At $183, it's over $40 cheaper than the MSI X99A SLI Plus from last issue, yet it still provides us with all the connectivity and power we were utilizing anyway. Because of this, we had to swap out the chassis to something more fitting—Fractal Design's Define Mini C Windowed edition—shaving off another $82, and then managed even greater savings by swapping from MSI's GTX 1080 Gaming X to EVGA's SC Gaming ACX, which propped us up with another $60 on top. This meant we could plump for some fancier accessories elsewhere, and still save a boatload. We bumped up the cooler to the stunningly beautiful NZXT Kraken X52 AIO, and could even afford to drop another $30 on Corsair's legendary Dominator Platinums. We also saw a price drop of $84 on Samsung's 960 Pro 1TB. What this all adds up to, even with the splurge on prettier cooling and memory, is a saving of $186 over last issue. Pump that into the processor, and you could grab the slightly better specced Core i7-6850K to net an additional 12 PCIe lanes and a 0.2GHz core clock increase at stock. However, we'd advise you to just grab a custom cable kit and some better fans instead.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	Fractal Design Define Mini C Windowed	**NEW**	$88
PSU	EVGA SuperNOVA G2 750W		$100
Mobo	EVGA X99 Micro 2	**NEW**	$183
CPU	Intel Core i7-6800K		$440
Cooler	NZXT Kraken X52 240mm AIO	**NEW**	$150
GPU	EVGA GTX 1080 SC Gaming ACX 3.0	**NEW**	$590
RAM	32GB (4x 8GB) Corsair Dominator Platinum DDR4-2400	**NEW**	$250
SSD	1TB Samsung 960 Pro M.2 NVMe SSD		$630
HDD	2x 2TB WD Black 7,200rpm 3.5-inch SATA		$238
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $2,769

UPGRADE OF THE MONTH

NZXT KRAKEN X52

Choosing how to cool your prized processor is always a curious decision. For instance, forking out extra cash for what amounts to a slim 240mm radiator rarely offers any greater advantage over another model, outside of a better designed fan and easier mounting solutions. However, we just can't get past how fantastic the Kraken X52 is. With a plethora of lighting options, it's a meeting of minds between the gaming RGB craze that's been forced upon us and a desire to retain a degree of professionalism that, arguably, all our readers wish to see in their purchases.

$150, www.nzxt.com

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